

# PROJECT MANUAL

## *Volume 1*

*Construct New Headquarters*

*Troop A Headquarters, MSHP*

*Lee's Summit, Missouri*

Designed By: Gastinger Walker  
817 Wyandotte  
Kansas City, MO 64105

Date Issued: August 1, 2023

Project No.: R2219-01

STATE of MISSOURI

OFFICE of ADMINISTRATION  
Facilities Management, Design & Construction

**SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS**

**PROJECT NUMBER: R2219-01**

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

**CIVIL ENGINEER - PHELPS ENGINEERING**

**CERTIFICATE OF AUTHORITY NUMBER: PE-29850**

This seal is authorizing Technical Specifications contained in:

Division 02

Division 31

Division 32

Section 321000

Section 322000

Section 323000

Section 323223

Section 324000

Division 33



**PROJECT NUMBER: R2219-01**

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

**LANDSCAPE ARCHITECT - MEIER LANDSCAPE ARCHITECTURE**  
**CERTIFICATE OF AUTHORITY NUMBER: LA-2009014761**

This seal is authorizing Technical Specifications contained in:  
Division 32

- Section 328400
- Section 329200
- Section 329300



**PROJECT NUMBER: R2219-01**

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

**STRUCTURAL ENGINEER - BOB D. CAMPBELL & COMPANY**  
**CERTIFICATE OF AUTHORITY NUMBER: 000442**

This seal is authorizing Technical Specifications contained in:

Division 03

Section 033000

Section 034713

Division 04

Section 042000

Division 05

Section 051200

Section 052100

Section 053100

Section 054000



**PROJECT NUMBER: R2219-01**

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

**ARCHITECT - GASTINGERWALKER& ARCHITECTS, LLC.**  
**CERTIFICATE OF AUTHORITY NUMBER: 2023012872**

This seal is authorizing Technical Specifications contained in:

Division 01

Division 05

Section 055000

Division 06

Division 07

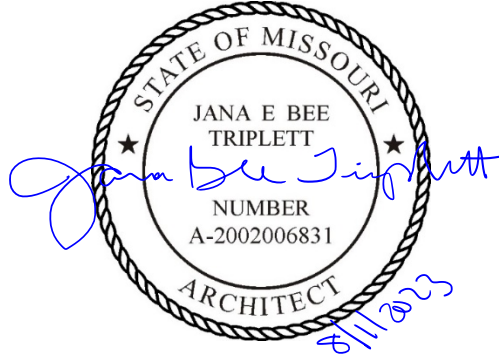
Division 08

Division 09

Division 10

Division 11

Division 12



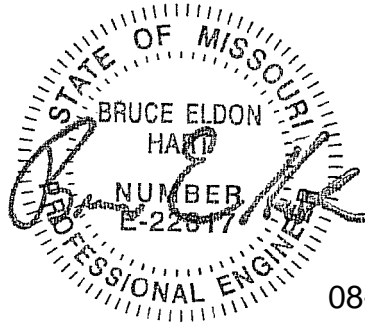
**PROJECT NUMBER: R2219-01**

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

**MECHANICAL, PLUMBING, ELECTRICAL & TECHNOLOGY ENGINEER - IMEG**  
**CERTIFICATE OF AUTHORITY NUMBER: F001325536**

This seal is authorizing Technical Specifications contained in:

- Division 21
- Division 22
- Division 23
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08-01-2023

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- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

**1.2 SUMMARY**

- A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

**PART 2 - PRODUCTS (NOT APPLICABLE)****PART 3 - EXECUTION****3.1 LIST OF DRAWINGS**

- A. The following list of drawings is a part of the Bid Documents:

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9.	Enlarged Grading Plan	C-302	08/01/23	C-302
10.	Enlarged Grading Plan	C-303	08/01/23	C-303
11.	Enlarged Grading Plan	C-304	08/01/23	C-304
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END OF SECTION 000115

## SECTION 001116 - INVITATION FOR BID

### 1.0 OWNER:

- A. The State of Missouri  
Office of Administration,  
Division of Facilities Management, Design and Construction  
Jefferson City, Missouri

### 2.0 PROJECT TITLE AND NUMBER:

- A. Construct New Headquarters  
MSHP Troop A Headquarters  
Lee's Summit, Missouri  
**Project No.: R2219-01**

### 3.0 BIDS WILL BE RECEIVED:

- A. Until: 1:30 PM, Tuesday, October 3, 2023
- B. **Only electronic bids on MissouriBUYS shall be accepted: <https://missouribuys.mo.gov>. Bidder must be registered to bid.**

### 4.0 DESCRIPTION:

- A. Scope: The project includes constructing two new building of tilt-up concrete panels. Main building has steel structure and a TPO roof on steel decking and joists. Firing range building has steel structure and a TPO roof on a combination of steel decking, joists and precast concrete. The main building has a fire sprinkler system and a backup generator. Both buildings are served by ground-mount and rooftop HVAC units.
- B. MBE/WBE/SDVE Goals: MBE 10%, WBE 10%, and SDVE 3%. **NOTE: Only MBE/WBE firms certified by the State of Missouri Office of Equal Opportunity as of the date of bid opening, or SDVE(s) meeting the requirements of Section 34.074, RSMo and 1 CSR 30-5.010, can be used to satisfy the MBE/WBE/SDVE participation goals for this project.**
- C. **\*\*NOTE:** Bidders are provided new Good Faith Effort (GFE) forms on MissouriBUYS.

### 5.0 PRE-BID MEETING:

- A. Place/Time: 10:30 AM, Tuesday, September, 12, 2023, at MSHP Motor Vehicle Inspection & Driver Examination Building. 1950 N.E. Independence Avenue, Lee's Summit, MO 64064.
- B. Access to State of Missouri property requires presentation of a photo ID by all persons

### 6.0 HOW TO GET PLANS & SPECIFICATIONS:

- A. View Only Electronic bid sets are available at no cost or paper bid sets for a deposit of \$200.00 from American Document Solutions (ADS). MAKE CHECKS PAYABLE TO: American Document Solutions. Mail to: American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433, <https://www.adsplanroom.net>. NOTE: Prime contractors will be allowed a maximum of two bid sets at the deposit rate shown above. Other requesters will be allowed only one bid set at this rate. Additional bid sets or parts thereof may be obtained by any bidder at the cost of printing and shipping by request to American Document Solutions at the address shown above. **Bidder must secure at least one bid set to become a planholder.**
- B. **Refunds: Return plans and specifications in unmarked condition within 15 working days of bid opening to American Document Solutions, 1400 Forum Blvd., Suite 7A, Columbia, Missouri 65203. Phone 573-446-7768, Fax 573-355-5433. Deposits for plans not returned within 15 working days shall be forfeited.**
- C. Information for upcoming bids, including downloadable plans, specifications, Invitation for Bid, bid tabulation, award, addenda, and access to the ADS planholders list, is available on the Division of Facilities Management, Design and Construction's web site: <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans>.

### 7.0 POINT OF CONTACT:

- A. Designer: Gastinger Walker, Andy Meyer, 816-569-0824, email: [ameyer@gastingerwalker.com](mailto:ameyer@gastingerwalker.com)  
Laura Scott, 816-569-0834, email: [lscott@gastingerwalker.com](mailto:lscott@gastingerwalker.com)
- B. Project Manager: Christopher Lloyd, 573-526-0160, email: [Christopher.Lloyd@oa.mo.gov](mailto:Christopher.Lloyd@oa.mo.gov)

### 8.0 GENERAL INFORMATION:

- A. The State reserves the right to reject any and all bids and to waive all informalities in bids. No bid may be withdrawn for a period of 20 working days subsequent to the specified bid opening time. The contractor shall pay not less than the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed, as determined by the Missouri Department of Labor and Industrial Relations and as set out in the detailed plans and specifications.
- B. Bid results will be available at <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans> after it is verified that at least one bid is awardable and affordable.

## Very Important MissouriBUYS Instructions to Help Submit a Bid Correctly

- A. The bidder shall submit his or her bid and all supporting documentation on MissouriBUYS eProcurement System. No hard copy bids shall be accepted. Go to <https://missouribuys.mo.gov> and register. The bidder must register and complete a profile fully with all required documents submitted prior to submitting a bid.
- B. Once registered, log in.
1. Under "Solicitation" select "View Current Solicitations."
  2. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8", then click "Filter Solicitation" button.
  3. Select "Active Solicitations" tab.
  4. To see the Solicitation Summary, click on the Project Number and the summary will open. Click each heading to open detailed information.
- C. Here are simplified instructions for uploading the bid to MissouriBUYS:
1. Find the solicitation by completing Steps 1 through 4 above.
  2. Select the three dots under "Actions." Select "Add New Response."
  3. When the Quote box opens, give the response a title and select "OK."
  4. The detailed solicitation will open. Select "Check All" for the Original Solicitation Documents, open each document, and select "Accept." If this step is not completed, a bid cannot be uploaded. Scroll to the bottom of the page and select "Add Attachments." If you do not see this command, not all documents have been opened and accepted.
  5. The Supplier Attachments box will open. Select "Add Attachment" again.
  6. The Upload Documents box will open. Read the instructions for uploading. Disregard the "Confidential" check box.
  7. Browse and attach up to 5 files at a time. Scroll to bottom of box and select "Upload." The Supplier Attachments box will open. Repeat Steps 5 through 7 if more than 5 files are to be uploaded.
  8. When the Supplier Attachments box opens again and uploading is complete, select "Done." A message should appear that the upload is successful. If it does not, go to the Bidder Response tab and select "Submit."
  9. The detailed solicitation will open. At the bottom select "Close."
- D. Any time a bidder wants to modify the bid, he or she will have to submit a new one. FMDC will open the last response the bidder submits. The bidder may revise and submit the bid up to the close of the solicitation (bid date and time). Be sure to allow for uploading time so that the bid is successfully uploaded prior to the 1:30 PM deadline; we can only accept the bid if it is uploaded before the deadline.
- E. If you want to verify that you are uploading documents correctly, please contact Paul Girouard: 573-751-4797, [paul.girouard@oa.mo.gov](mailto:paul.girouard@oa.mo.gov) ; April Howser: 573-751-0053, [April.Howser@oa.mo.gov](mailto:April.Howser@oa.mo.gov) ; or Mandy Roberson: 573-522-0074, [Mandy.Roberson@oa.mo.gov](mailto:Mandy.Roberson@oa.mo.gov).
- F. If you are experiencing login issues, please contact Web Procure Support (Proactis) at 866-889-8533 anytime from 7:00 AM to 7:00 PM Central Time, Monday through Friday. If you try using a userid or password several times that is incorrect, the system will lock you out. Web Procure Support is the only option to unlock you! If you forget your userid or password, Web Procure Support will provide a temporary userid or password. Also, if it has been a while since your last successful login and you receive an "inactive" message, contact Web Procure (Proactis). If you are having a registration issue, you may contact Cathy Holliday at 573-751-3491 or by email: [cathy.holliday@oa.mo.gov](mailto:cathy.holliday@oa.mo.gov).

## IMPORTANT REMINDER REGARDING REQUIREMENT FOR OEO CERTIFICATION

A. SECTION 002113 – INSTRUCTIONS TO  
BIDDERS: Article 15.0, Section D1:

**As of July 1, 2020**, all MBE, WBE, and MBE/WBE contractors, subcontractors, and suppliers must be certified by the State of Missouri, Office of Equal Opportunity. No certifications from other Missouri certifying agencies will be accepted.

## **SECTION 002113 – INSTRUCTIONS TO BIDDERS**

### **1.0 - SPECIAL NOTICE TO BIDDERS**

- A. If awarded a contract, the Bidder's employees, and the employees of all subcontractors, who perform the work on the project must adhere to requirements in Section 013513 – Site Security and Health Requirements as applicable per Agency.
- B. The Bidder's prices shall include all city, state, and federal sales, excise, and similar taxes that may lawfully be assessed in connection with the performance of work, and the purchased of materials to be incorporated in the work. THIS PROJECT IS NOT TAX EXEMPT.

### **2.0 - BID DOCUMENTS**

- A. The number of sets obtainable by any one (1) party may be limited in accordance with available supply.
- B. For the convenience of contractors, sub-contractors and suppliers, copies of construction documents are on file at the office of the Director, Division of Facilities Management, Design and Construction and on the Division's web site - <https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans>.

### **3.0 - BIDDERS' OBLIGATIONS**

- A. Bidders must carefully examine the entire site of the work and shall make all reasonable and necessary investigations to inform themselves thoroughly as to the facilities available as well as to all the difficulties involved in the completion of all work in accordance with the specifications and the plans. Bidders are also required to examine all maps, plans and data mentioned in the specifications. No plea of ignorance concerning observable existing conditions or difficulties that may be encountered in the execution of the work under this contract will be accepted as an excuse for any failure or omission on the part of the contractor to fulfill in every detail all of the requirements of the contract, nor accepted as a basis for any claims for extra compensation.
- B. Under no circumstances will contractors give their plans and specifications to another contractor. Any bid received from a contractor whose name does not appear on the list of plan holders may be subject to rejection.

### **4.0 - INTERPRETATIONS**

- A. No bidder shall be entitled to rely on oral interpretations as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction. Every request for interpretation shall be made in writing and submitted with all supporting documents not less than five (5) working days before opening of bids. Every interpretation made to a bidder will be in the form of an addendum and will be sent as promptly as is practicable to all persons to whom plans and specifications have been issued. All such addenda shall become part of the contract documents.
- B. Approval for an "acceptable substitution" issued in the form of an addendum as per Paragraph 4A above, and as per Article 3.1 of the General Conditions; ACCEPTABLE SUBSTITUTIONS shall constitute approval for use in the project of the product.
- C. An "acceptable substitution" requested after the award of bid shall be approved if proven to the satisfaction of the Owner and the Designer as per Article 3.1, that the product is acceptable in design, strength, durability, usefulness, and convenience for the purpose intended. Approval of the substitution after award is at the sole discretion of the Owner.
- D. A request for "Acceptable Substitutions" shall be made on the Section 006325 Substitution Request Form. The request shall be sent directly to the project Designer. A copy of said request should also be mailed to the Owner, Division of Facilities Management, Design and Construction, Post Office Box 809, Jefferson City, Missouri 65102.

## **5.0 - BIDS AND BIDDING PROCEDURE**

- A. Bidders shall submit all submission forms and accompanying documents listed in SECTION 004113 – BID FORM, Article 5.0, ATTACHMENTS TO BID by the stated time or their bid will be rejected for being non-responsive.

Depending on the specific project requirements, **the following is a GENERIC list** of all possible bid forms that may be due with bid submittals and times when they may be due. Please check for specific project requirements on the proposal form (Section 004113). ***Not all of the following bid forms may be required to be submitted.***

### **Bid Submittal – due before stated date and time of bid opening (see IFB):**

004113	Bid Form (all pages are always required)
004322	Unit Prices Form
004336	Proposed Subcontractors Form
004337	MBE/WBE/SDVE Compliance Evaluation Form
004338	MBE/WBE/SDVE Eligibility Determination for Joint Ventures
004339	MBE/WBE/SDVE GFE Determination
004340	SDVE Business Form
004541	Affidavit of Work Authorization
004545	Anti-Discrimination Against Israel Act Certification form

- B. All bids shall be submitted without additional terms and conditions, modification or reservation on the bid forms with each space properly filled. Bids not on these forms will be rejected.
- C. All bids shall be accompanied by a bid bond executed by the bidder and a duly authorized surety company, certified check, cashier's check or bank draft made payable to the Division of Facilities Management, Design and Construction, State of Missouri, in the amount indicated on the bid form, Section 004113. Failure of the contractor to submit the full amount required shall be sufficient cause to reject his bid. The bidder agrees that the proceeds of the check, draft or bond shall become the property of the State of Missouri, if for any reason the bidder withdraws his bid after closing, or if on notification of award refuses or is unable to execute tendered contract, provide an acceptable performance and payment bond, provide evidence of required insurance coverage and/or provide required copies of affirmative action plans within ten (10) working days after such tender.
- D. The check or draft submitted by the successful bidder will be returned after the receipt of an acceptable performance and payment bond and execution of the formal contract. Checks or drafts of all other bidders will be returned within a reasonable time after it is determined that the bid represented by same will receive no further consideration by the State of Missouri. Bid bonds will only be returned upon request.

## **6.0 - SIGNING OF BIDS**

- A. A bid from an individual shall be signed as noted on the Bid Form.
- B. A bid from a partnership or joint venture shall require only one signature of a partner, an officer of the joint venture authorized to bind the venture or an attorney-in-fact. If the bid is signed by an officer of a joint venture or an attorney-in-fact, a document evidencing the individual's authority to execute contracts should be included with the bid form.
- C. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.
- D. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual. Corporate license number shall be provided and, if a corporation organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached. In addition, for corporate proposals, the President or Vice-President should sign as the bidder. If the signator is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signator has the legal authority to bind the corporation.

- E. A bid should contain the full and correct legal name of the Bidder. If the Bidder is an entity registered with the Missouri Secretary of State, the Bidder's name on the bid form should appear as shown in the Secretary of State's records.
- F. The Bidder should include its corporate license number on the Bid Form and, if the corporation is organized in a state other than Missouri, a Certificate of Authority to do business in the State of Missouri shall be attached to the bid form.

#### **7.0 - RECEIVING BID SUBMITTALS**

- A. It is the bidder's sole responsibility to assure receipt by Owner of bid submittals by the date and time specified in the Invitation for Bid. Bids received after the date and time specified shall not be considered by the Owner.
- B. Bids must be submitted through the MissouriBUYS statewide eProcurement system (<https://www.missouribuys.mo.gov/>) in accordance with the instructions for that system. The Owner shall only accept bids submitted through MissouriBUYS. Bids received by the Owner through any other means, including hard copies, shall not be considered and will be discarded by the Owner unopened.
- C. To respond to an Invitation for Bid, the Bidder must first register with MissouriBUYS by going through the MissouriBUYS Home Page (<https://www.missouribuys.mo.gov/>), clicking the "Register" button at the top of the page, and completing the Vendor Registration. Once registered, the Bidder accesses its account by clicking the "Login" button at the top of the MissouriBUYS Home Page. Enter your USERID and PASSWORD, which the Bidder will select. Under Solicitations, select "View Current Solicitations." A new screen will open. Under "Filter by Agency" select "OA-FMDC-Contracts Chapter 8." Under "Filter by Opp. No." type in the State Project Number. Select "Submit." Above the dark blue bar, select "Other Active Opportunities." To see the Solicitation Summary, single click the Opp. No. (Project Number) and the summary will open. Single quick click each blue bar to open detailed information. The Bidder must read and accept the Original Solicitation Documents and complete all identified requirements. The Bidder should download and save all of the Original Solicitation Documents on its computer so that the Bidder can prepare its response to these documents. The Bidder should upload its completed response to the downloaded documents as an attachment to the electronic solicitation response.
- D. Step-by-step instructions for how a registered vendor responds to a solicitation electronically are provided in Section 001116 – Invitation For Bid.
- E. The Bidder shall submit its bid on the forms provided by the Owner on MissouriBUYS with each space fully and properly completed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner may reject bids that are not on the Owner's forms or that do not contain all requested information.
- F. No Contractor shall stipulate in his bid any conditions not contained in the specifications or standard bid form contained in the contract documents. To do so may subject the Contractor's bid to rejection.
- G. The completed forms shall be without interlineations, alterations or erasures.

#### **8.0 - MODIFICATION AND WITHDRAWAL OF BIDS**

- A. Bidder may withdraw his bid at any time prior to scheduled closing time for receipt of bids, but no bidder may withdraw his bid for a period of twenty (20) working days after the scheduled closing time for receipt of bids.
- B. The Bidder shall modify his or her original bid by submitting a revised bid on MissouriBUYS.

#### **9.0 - AWARD OF CONTRACT**

- A. The Owner reserves the right to reject any and/or all bids and further to waive all informalities in bidding when deemed in the best interest of the State of Missouri.
- B. The Owner reserves the right to let other contracts in connection with the work, including but not by way of limitation, contracts for the furnishing and installation of furniture, equipment, machines, appliances and other apparatus.

- C. The Owner shall award a contract to the lowest, responsive, responsible Bidder in accordance with Section 8.250, RSMo. No contract will be awarded to any Bidder who has had a contract with the Owner terminated within the preceding twelve months for material breach of contract or who has been suspended or debarred by the Owner.
- D. Award of alternates, if any, will be made in numerical order unless all bids received are such that the order of acceptance of alternates does not affect the determination of the lowest, responsive, responsible bidder.
- E. No bid shall be considered binding upon the Owner until the written contract has been properly executed, a satisfactory bond has been furnished, evidence of required insurance coverage, submittal of executed Section 004541, Affidavit of Work Authorization form, documentation evidencing enrollment and participation in a federal work authorization program has been received and an affirmative action plan submitted. Failure to execute and return the contract and associated documents within the prescribed period of time shall be treated, at the option of the Owner, as a breach of bidder's obligation and the Owner shall be under no further obligation to bidder.
- F. If the successful bidder is doing business in the State of Missouri under a fictitious name, he shall furnish to Owner, attached to the Bid Form, a properly certified copy of the certificate of Registration of Fictitious Name from the State of Missouri, and such certificate shall remain on file with the Owner.
- G. Any successful bidder which is a corporation organized in a state other than Missouri shall furnish to the Owner, attached to the Bid Form, a properly certified copy of its current Certificate of Authority to do business in the State of Missouri, such certificate to remain on file with the Owner. No contract will be awarded by the Owner unless such certificate is furnished by the bidder.
- H. Any successful bidder which is a corporation organized in the State of Missouri shall furnish at its own cost to the Owner, if requested, a Certificate of Good Standing issued by the Secretary of State, such certificate to remain on file with the Owner.
- I. Transient employers subject to Sections 285.230 and 285.234, RSMo, (out-of-state employers who temporarily transact any business in the State of Missouri) may be required to file a bond with the Missouri Department of Revenue. No contract will be awarded by the Owner unless the successful bidder certifies that he has complied with all applicable provisions of Section 285.230-234.
- J. Sections 285.525 and 285.530, RSMo, require business entities to enroll and participate in a federal work authorization program in order to be eligible to receive award of any state contract in excess of \$5,000. Bidders should submit with their bid an Affidavit of Work Authorization (Section 004541) along with appropriate documentation evidencing such enrollment and participation. Section-004541, Affidavit of Work Authorization is located on the MissouriBUYS solicitation for this project. Bidders must also submit an E-Verify Memorandum before the Owner may award a contract to the Bidder. Information regarding an E-Verify is located at <https://www.uscis.gov/e-verify/>. The contractor shall be responsible for ensuring that all subcontractors and suppliers associated with this contract enroll in E-Verify.

#### **10.0 - CONTRACT SECURITY**

- A. The successful bidder shall furnish a performance/payment bond as set forth in General Conditions Article 6.1 on a condition prior to the State executing the contract and issuing a notice to proceed.

#### **11.0 - LIST OF SUBCONTRACTORS**

- A. If required by "Section 004113 – Bid Form," each bidder must submit as part of their bid a list of subcontractors to be used in performing the work (Section 004336). The list must specify the name of the single designated subcontractor, for each category of work listed in "Section 004336 - Proposed Subcontractors Form." If work within a category will be performed by more than one subcontractor, the bidder must provide the name of each subcontractor and specify the exact portion of the work to be done by each. Failure to list the Bidder's firm, or a subcontractor for each category of work identified on the Bid Form or the listing of more than one subcontractor for any category without designating the portion of work to be performed by each shall be cause for rejection of the bid. If the bidder intends to perform any of the designated subcontract work with the use of his own employees, the bidder shall make that fact clear, by listing his own firm for the subject category. **If any category of work is left vacant, the bid shall be rejected.**



## **12.0 - WORKING DAYS**

- A. Contract duration time is stated in working days and will use the following definition in determining the actual calendar date for contract completion:
  - 1. Working days are defined as all calendar days except Saturdays, Sundays and the following State of Missouri observed holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday, Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day.

## **13.0 - AMERICAN AND MISSOURI - MADE PRODUCTS AND FIRMS**

- A. By signing the bid form and submitting a bid on this project, the Bidder certifies that it will use American and Missouri products as set forth in Article 1.7 of the General Conditions. Bidders are advised to review those requirements carefully prior to bidding.
- B. A preference shall be given to Missouri firms, corporations or individuals, or firms, corporations or individuals that maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less.
- C. Pursuant to Section 34.076, RSMo, a contractor or Bidder domiciled outside the boundaries of the State of Missouri shall be required, in order to be successful, to submit a bid the same percent less than the lowest bid submitted by a responsible contractor or Bidder domiciled in Missouri as would be required for such a Missouri domiciled contractor or Bidder to succeed over the bidding contractor or Bidder domiciled outside Missouri on a like contract or bid being let in the person's domiciliary state and, further, the contractor or Bidder domiciled outside the boundaries of Missouri shall be required to submit an audited financial statement as would be required of a Missouri domiciled contractor or Bidder on a like contract or bid being let in the domiciliary state of that contractor or Bidder.

## **14.0 – ANTI-DISCRIMINATION AGAINST ISRAEL ACT CERTIFICATION:**

- A. Pursuant to section 34.600, RSMo, if the Bidder meets the section 34.600, RSMo, definition of a “company” and the Bidder has ten or more employees, the Bidder must certify in writing that the Bidder is not currently engaged in a boycott of goods or services from the State of Israel as defined in section 34.600, RSMo, and shall not engage in a boycott of goods or services from the State of Israel, if awarded a contract, for the duration of the contract. The Bidder is requested to complete and submit the applicable portion of Section 004545 - Anti-Discrimination Against Israel Act Certification with their Bid Form. The applicable portion of the exhibit must be submitted prior to execution of a contract by the Owner and issuance of Notice to Proceed. If the exhibit is not submitted, the Owner shall rescind its Intent to Award and move to the next lowest, responsive, responsible bidder.

## **15.0 - MBE/WBE/SDVE INSTRUCTIONS**

- A. Definitions:
  - 1. “**MBE**” means a Minority Business Enterprise.
  - 2. “**MINORITY**” has the same meaning as set forth in 1 C.S.R. 10-17.010.
  - 3. “**MINORITY BUSINESS ENTERPRISE**” has the same meaning as set forth in section 37.020, RSMo.
  - 4. “**WBE**” means a Women’s Business Enterprise.
  - 5. “**WOMEN’S BUSINESS ENTERPRISE**” has the same meaning as set forth in section 37.020, RSMo.
  - 6. “**SDVE**” means a Service-Disabled Veterans Enterprise.
  - 7. “**SERVICE-DISABLED VETERAN**” has the same meaning as set forth in section 34.074, RSMo.
  - 8. “**SERVICE-DISABLED VETERAN ENTERPRISE**” has the same meaning as “Service-Disabled Veteran Business” set forth in section 34.074, RSMo.

B. MBE/WBE/SDVE General Requirements:

1. For all bids greater than \$100,000, the Bidder shall obtain MBE, WBE and SDVE participation in an amount equal to or greater than the percentage goals set forth in the Invitation for Bid and the Bid Form, unless the Bidder is granted a Good Faith Effort waiver by the Director of the Division, as set forth below. If the Bidder does not meet the MBE, WBE and SDVE goals, or make a good faith effort to do so, the Bidder shall be non-responsive, and its bid shall be rejected.
2. The Bidder should submit with its bid all of the information requested in the MBE/WBE/SDVE Compliance Evaluation Form for every MBE, WBE, or SDVE subcontractor or material supplier the Bidder intends to use for the contract work. The Bidder is required to submit all appropriate MBE/WBE/SDVE documentation before the stated time and date set forth in the Invitation for Bid. If the Bidder fails to provide such information by the specified date and time, the Owner shall reject the bid.
3. The Director reserves the right to request additional information from a Bidder to clarify the Bidder's proposed MBE, WBE, and/or SDVE participation. The Bidder shall submit the clarifying information requested by the Owner within two (2) Working Days of receiving the request for clarification.
4. Pursuant to section 34.074, RSMo, a Bidder that is a SDVE doing business as Missouri firm, corporation, or individual, or that maintains a Missouri office or place of business, shall receive a three-point bonus preference in the contract award evaluation process. The bonus preference will be calculated and applied by reducing the bid amount of the eligible SDVE by three percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible SDVE's evaluation is less than the apparent low responsive bidder's bid, the eligible SDVE's bid becomes the apparent low responsive bid. This reduction is for evaluation purposes only, and will have no impact on the actual amount(s) of the bid or the amount(s) of any contract awarded. In order to be eligible for the SDVE preference, the Bidder must complete and submit with its bid the Missouri Service Disabled Veteran Business Form, and any information required by the form. The form is available on the MissouriBUYS solicitation for this project.

C. Computation of MBE/WBE/SDVE Goal Participation:

1. A Bidder who is a MBE, WBE, or SDVE may count 100% of the contract towards the MBE, WBE or SDVE goal, less any amounts awarded to another MBE, WBE or SDVE. (NOTE: A MBE firm that bids as general contractor must obtain WBE and SDVE participation; a WBE firm that bids as a general contractor must obtain MBE and SDVE participation; and a SDVE firm that bids as general contractor must obtain MBE and WBE participation.) In order for the remaining contract amount to be counted towards the MBE, WBE or SDVE goal, the Bidder must complete the MBE/WBE/SDVE Compliance Evaluation Form (Section 004337) identifying itself as an MBE, WBE or SDVE.
2. The total dollar value of the work granted to a certified MBE, WBE or SDVE by the Bidder shall be counted towards the applicable goal.
3. Expenditures for materials and supplies obtained from a certified MBE, WBE, or SDVE supplier or manufacturer may be counted towards the MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE assumes the actual and contractual responsibility for the provision of the materials and supplies.
4. The total dollar value of the work granted to a second or subsequent tier subcontractor or a supplier may be counted towards a Bidder's MBE, WBE and SDVE goals, if the MBE, WBE, or SDVE properly assumes the actual and contractual responsibility for the work.
5. The total dollar value of work granted to a certified joint venture equal to the percentage of the ownership and control of the MBE, WBE, or SDVE partner in the joint venture may be counted towards the MBE/WBE/SDVE goals.
6. Only expenditures to a MBE, WBE, or SDVE that performs a commercially useful function in the work may be counted towards the MBE, WBE and SDVE goals. A MBE, WBE, or SDVE performs a commercially useful function when it is responsible for executing a distinct element of the work and carrying out its responsibilities by actually performing, managing and supervising the work or providing supplies or manufactured materials.

D. Certification of MBE/WBE/SDVE Subcontractors:

1. In order to be counted towards the goals, an MBE or WBE must be certified by the State of Missouri Office of Equal Opportunity and an SDVE must be certified by the State of Missouri, Office of Administration, Division of Purchasing and Material Management or by the Department of Veterans Affairs.
2. The Bidder may determine the certification status of a proposed MBE or WBE subcontractor or supplier by referring to the Office of Equal Opportunity (OEO)'s online MBE/WBE directory (<https://apps1.mo.gov/MWBCertifiedFirms/>). The Bidder may determine the eligibility of a SDVE subcontractor or supplier by referring to the Division of Purchasing and Materials Management's online SDVE directory (<https://oa.mo.gov/sites/default/files/sdvelisting.pdf>) or the Department of Veterans Affairs' directory (<https://vetbiz.va.gov/basic-search/>).
3. Additional information, clarifications, etc., regarding the listings in the directories may be obtained by calling the Division at (573)751-3339 and asking to speak to the Contract Specialist of record as shown in the Supplementary Conditions (Section 007300).

E. Waiver of MBE/WBE/SDVE Participation:

1. If a Bidder has made a good faith effort to secure the required MBE, WBE and/or SDVE participation and has failed, the Bidder shall submit with its bid the information requested in MBE/WBE/SDVE Good Faith Effort (GFE) Determination form. The GFE forms are located on the MissouriBUYS solicitation for this project. The Director will determine if the Bidder made a good faith effort to meet the applicable goals. If the Director determines that the Bidder did not make a good faith effort, the bid shall be rejected as being nonresponsive to the bid requirements. Bidders who demonstrate that they have made a good faith effort to include MBE, WBE, and/or SDVE participation will be determined to be responsive to the applicable participation goals, regardless of the percent of actual participation obtained, if the bid is otherwise acceptable.
2. In determining whether a Bidder has made a good faith effort to obtain MBE, WBE and/or SDVE participation, the Director may evaluate the factors set forth in 1 CSR 30-5.010(6)(C) and the following:
  - a. The amount of actual participation obtained;
  - b. How and when the Bidder contacted potential MBE, WBE, and SDVE subcontractors and suppliers;
  - c. The documentation provided by the Bidder to support its contacts, including whether the Bidder provided the names, addresses, phone numbers, and dates of contact for MBE/WBE/SDVE firms contacted for specific categories of work;
  - d. If project information, including plans and specifications, were provided to MBE/WBE/SDVE subcontractors;
  - e. Whether the Bidder made any attempts to follow-up with MBE, WBE or SDVE firms prior to bid;
  - f. Amount of bids received from any of the subcontractors and/or suppliers that the Bidder contacted;
  - g. The Bidder's stated reasons for rejecting any bids;
3. If no bidder has obtained any participation in a particular category (MBE/WBE/SDVE) or made a good faith effort to do so, the Director may waive that goal rather than rebid.

F. Contractor MBE/WBE/SDVE Obligations

1. If awarded a contract, the Bidder will be contractually required to subcontract with or obtain materials from the MBE, WBE, and SDVE firms listed in its bid, in amounts equal to or greater than the dollar amount bid, unless the amount is modified in writing by the Owner.
2. If the Contractor fails to meet or maintain the participation requirements contained in the Contractor's bid, the Contractor must satisfactorily explain to the Director why it cannot comply with the requirement and why failing meeting the requirement was beyond the Contractor's control. If the Director finds the Contractor's explanation unsatisfactory, the Director may take any appropriate action including, but not limited to:
  - a. Declaring the Contractor ineligible to participate in any contracts with the Division for up to twelve (12) months (suspension); and/or
  - b. Declaring the Contractor be non-responsive to the Invitation for Bid, or in breach of contract and rejecting the bid or terminating the contract.
3. If the Contractor replaces an MBE, WBE, or SDVE during the course of this contract, the Contractor shall replace it with another MBE, WBE, or SDVE or make a good faith effort to do so. All MBE, WBE and SDVE substitutions must be approved by the Director.
4. The Contractor shall provide the Owner with regular reports on its progress in meeting its MBE/WBE/SDVE obligations. At a minimum, the Contractor shall report the dollar-value of work completed by each MBE, WBE, or SDVE during the preceding month and the cumulative total of work completed by each MBE, WBE or SDVE to date with each monthly application for payment. The Contractor shall also make a final report, which shall include the total dollar-value of work completed by each MBE, WBE, and SDVE during the entire contract.

**STATE OF MISSOURI  
DIVISION OF FACILITIES MANAGEMENT,  
DESIGN AND CONSTRUCTION  
*MBE/WBE/SDVE DIRECTORIES***

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The MBE/WBE Directory for goods and services is maintained by the Office of Equal Opportunity (OEO) and is located at the following web address:

<https://apps1.mo.gov/MWBCertifiedFirms/>

The SERVICE DISABLED VETERAN ENTERPRISE (SDVE) Directories may be accessed at the following web addresses:

<https://purch.oa.mo.gov/media/pdf/listing-certified-missouri-service-disabled-veteran-business-enterprises-sdves>

<https://veterans.certify.sba.gov/#search>



# State of Missouri Construction Contract

**THIS AGREEMENT** is made (DATE) by and between:

## *Contractor Name and Address*

hereinafter called the "Contractor,"

and the **State of Missouri**, hereinafter called the "**Owner**", represented by the Office of Administration, Division of Facilities Management, Design and Construction.

WITNESSETH, that the Contractor and the Owner, for the consideration stated herein agree as follows:

## **ARTICLE 1. STATEMENT OF WORK**

The Contractor shall furnish all labor and materials and perform all work required for furnishing and installing all labor, materials, equipment and transportation and everything necessarily inferred from the general nature and tendency of the plans and specifications for the proper execution of the work for:

**Project Name:**                    **Construct New Headquarters  
MSHP Troop A Headquarters  
Lee's Summit, Missouri**

**Project Number:**            **R2219-01**

in strict accordance with the Contract Documents as enumerated in Article 7, all of which are made a part hereof.

## **ARTICLE 2. TIME OF COMPLETION**

The contract performance time is **360 working days** from the transmittal date of this agreement. The contract completion date is **MONTH, DAY, YEAR**. This time includes ten (10) working days for the Contractor to receive, sign and return the contract form along with required bonding and insurance certificates. Failure of the Contractor to provide correct bonding and insurance within the ten (10) working days shall not be grounds for a time extension. Receipt of proper bonding and insurance is a condition precedent to the formation of the contract and if not timely received, may result in forfeiture of the Contractor's bid security. Work may not commence until the Owner issues a written Notice to Proceed and must commence within seven (7) working days thereafter.

## **ARTICLE 3. LIQUIDATED DAMAGES**

Whenever time is mentioned in this contract, time shall be and is of the essence of this contract. The Owner would suffer a loss should the Contractor fail to have the work embraced in this contract fully completed on or before the time above specified. **THEREFORE**, the parties hereto realize in order to adjust satisfactorily the damages on account of such failure that it might be impossible to compute accurately or estimate the amount of such loss or damages which the Owner would sustain by reason of failure to complete fully said work within the time required by this contract. The Contractor hereby covenants and agrees to pay the Owner, as and for **liquidated damages, the sum of \$1,000** per day for each and every day, Sunday and legal holidays excepted, during which the work remains incomplete and unfinished. Any sum which may be due the Owner for such damages shall be deducted and retained by the Owner from any balance which may be due the Contractor when said work shall have been finished and accepted. But such provisions shall not release the Bond of the Contractor from liability according to its terms. In case of failure to complete, the Owner will be under no obligation to show or prove any actual or specific loss or damage.

**ARTICLE 4. CONTRACT SUM**

The Owner shall pay the Contractor for the prompt, faithful and efficient performance of the conditions and undertakings of this contract, subject to additions, and deductions as provided herein, in current funds the sum of:

Base Bid:	\$
Alternate No. 1:	\$
Alternate No. 2:	\$
Alternate No. 3:	\$
Alternate No. 4:	\$

**TOTAL CONTRACT AMOUNT:** (\$CONTRACT AMOUNT)

**UNIT PRICES:** The Owner accepts the following Unit Prices:

For changing specified quantities of work from those indicated by the contract drawings and specifications, upon written instructions of Owner, the following unit prices shall prevail. The unit prices include all labor, overhead and profit, materials, equipment, appliances, bailing, shoring, shoring removal, etc., to cover the finished work of the several kinds of work called for. Only a single unit price shall be given and it shall apply for either MORE or LESS work than that shown on the drawings and called for in the specifications or included in the Base Bid. In the event of more or less units than so indicated or included, change orders may be issued for the increased or decreased amount.

**ARTICLE 5. PREVAILING WAGE RATE**

**MISSOURI PREVAILING WAGE LAW (Sections 290.210 to 290.340, RSMo):** The Contractor shall pay not less than the specified hourly rate of wages, as set out in the wage order attached to and made part of the specifications for work under this contract, to all workers performing work under the contract, in accordance with sections 290.210 to 290.340, RSMo. The Contractor shall forfeit a penalty to the Owner of one hundred dollars per day (or portion of a day) for each worker that is paid less than the specified rates for any work done under the contract by the Contractor or by any subcontractor, in accordance with section 290.250, RSMo.

**DAVIS-BACON ACT:** If this Project is financed in whole or in part from Federal funds (as indicated in the Instructions to Bidders or other bid or contract documents for this Project), then this contract shall be subject to all applicable federal labor statutes, rules and regulations, including provisions of the Davis-Bacon Act, 40 U.S.C. §3141 et seq., and the “Federal Labor Standards Provisions,” as further set forth in Section 007333 – Supplementary General Conditions for Federally Funded/Assisted Construction Projects, which is incorporated into the contract by reference. Where the Missouri Prevailing Wage Law and the Davis-Bacon Act require payment of different wages for work performed under this contract, the Contractor and all Subcontractors shall pay the greater of the wages required under either law, on a classification by classification basis.

**ARTICLE 6. MINORITY/WOMEN/SERVICE DISABLED VETERAN BUSINESS ENTERPRISE PARTICIPATION**

The Contractor has been granted a waiver of the 10% MBE and 10% WBE and 3% SDVE participation goals. The Contractor agrees to secure the MBE/WBE/SDVE participation amounts for this project as follows: (OR)

The Contractor has met the MBE/WBE/SDVE participation goals and agrees to secure the MBE/WBE/SDVE participation amounts for this project as follows:

MBE/WBE/SDVE Firm:	Subcontract Amt:\$	
MBE/WBE/SDVE Firm:	Subcontract Amt:\$	
MBE/WBE/SDVE Firm:	Subcontract Amt:\$	
		Total \$

MBE/WBE/SDVE assignments identified above shall not be changed without a contract change signed by the Owner.

The Director of the Division of Facilities Management, Design and Construction or his Designee shall be the final authority to resolve disputes and disagreements between the Contractor and the MBE/WBE/SDVE firms listed above when such disputes impact the subcontract amounts shown above.

#### **ARTICLE 7. CONTRACT DOCUMENTS**

The following documents are hereby incorporated into this contract by reference (all division/section numbers and titles are as utilized in the Project Manual published by the Owner for this Project):

1. Division 0 – Procurement and Contracting Information, including, but not limited to:
  - a. Invitation for Bid (Section 001116)
  - b. Instructions to Bidders (Section 002113)
  - c. Supplementary Instructions to Bidders (if applicable) (Section 002213)
  - d. The following documents as completed and executed by the Contractor and accepted by the Owner, if applicable:
    - i. Bid Form (Section 004113)
    - ii. Unit Prices (Section 004322)
    - iii. Proposed Contractors Form (Section 004336)
    - iv. MBE, WBE, SDVE Compliance Evaluation Form(s) (Section 004337)
    - v. MBE, WBE, SDVE Eligibility Determination Form for Joint Ventures (Section 004338)
    - vi. MBE, WBE, SDVE Good Faith Effort (GFE) Determination Form (Section 004339)
    - vii. Missouri Service Disabled Veteran Business Form (Section 004340)
    - viii. Affidavit of Work Authorization (Section 004541)
    - ix. Affidavit for Affirmative Action (Section 005414)
  - e. Performance and Payment Bond, completed and executed by the Contractor and surety (Section 006113)
  - f. General Conditions (Section 007213)
  - g. Supplementary Conditions (Section 007300)
  - h. Supplementary General Conditions for Federally Funded/Assisted Construction Projects (Section 007333)
  - i. Wage Rate(s) (Section 007346)
2. Division 1 – General Requirements
3. All Drawings identified in the Project Manual
4. All Technical Specifications included in the Project Manual
5. Addenda, if applicable

#### **ARTICLE 8 – CERTIFICATION**

By signing this contract, the Contractor hereby re-certifies compliance with all legal requirements set forth in Section 6.0, Bidder’s Certifications of the Bid Form.

Further, if the Contractor provides any “personal information” as defined in §105.1500, RSMo concerning an entity exempt from federal income tax under Section 501(c) of the Internal Revenue Code of 1986, as amended, the Contractor understands and agrees that it is voluntarily choosing to enter into a state contract and providing such information for that purpose. The state will treat such personal information in accord with §105.1500, RSMo.



By signature below, the parties hereby execute this contract document.

**APPROVED:**

\_\_\_\_\_  
Brian Yansen, Director  
Division of Facilities Management,  
Design and Construction

\_\_\_\_\_  
Contractor's Authorized Signature

I, Corporate Secretary, certify that I am Secretary of the corporation named above and that (CONTRACTOR NAME), who signed said contract on behalf of the corporation, was then (TITLE) of said corporation and that said contract was duly signed for and in behalf of the corporation by authority of its governing body, and is within the scope of its corporate powers.

\_\_\_\_\_  
*Corporate Secretary*



STATE OF MISSOURI  
 OFFICE OF ADMINISTRATION  
 DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION  
**AFFIDAVIT FOR AFFIRMATIVE ACTION**

PROJECT NUMBER
----------------

NAME
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First being duly sworn on oath states: that

he/she is the  sole proprietor  partner  officer or  manager or managing member of

NAME
------

a  sole proprietorship  partnership  
 limited liability company (LLC)

or  corporation, and as such, said proprietor, partner, or officer is duly authorized to make this

affidavit on behalf of said sole proprietorship, partnership, or corporation; that under the contract known as

PROJECT TITLE
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Less than 50 persons in the aggregate will be employed and therefore, the applicable Affirmative Action requirements as set forth in Article 1.4 of the General Conditions of the State of Missouri have been met.

PRINT NAME & SIGNATURE
------------------------

DATE
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**NOTARY INFORMATION**

NOTARY PUBLIC EMBOSSER SEAL	STATE OF	COUNTY (OR CITY OF ST. LOUIS)	USE RUBBER STAMP IN CLEAR AREA BELOW
	SUBSCRIBED AND SWORN BEFORE ME, THIS		
	DAY OF	YEAR	
	NOTARY PUBLIC SIGNATURE	MY COMMISSION EXPIRES	
NOTARY PUBLIC NAME (TYPED OR PRINTED)			

**SECTION 006113 - PERFORMANCE AND PAYMENT BOND FORM**

KNOW ALL MEN BY THESE PRESENTS, THAT we \_\_\_\_\_

as principal, and \_\_\_\_\_

\_\_\_\_\_ as Surety, are held and firmly bound unto the

STATE OF MISSOURI. in the sum of \_\_\_\_\_ Dollars (\$ \_\_\_\_\_ )

for payment whereof the Principal and Surety bind themselves, their heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

WHEREAS, the Principal has, by means of a written agreement dated the \_\_\_\_\_

day of \_\_\_\_\_, 20\_\_\_\_\_, enter into a contract with the State of Missouri for

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(Insert Project Title and Number)

NOW, THEREFORE, if the Principal shall faithfully perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the State of Missouri, with or without notice to the Surety and during the life of any guaranty required under the contract; and shall also faithfully perform and fulfill all undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made with or without notice to the Surety; and shall also promptly make payment for materials incorporated, consumed or used in connection with the work set forth in the contract referred to above, and all insurance premiums, both compensation and all other kinds of insurance, on said work, and for all labor performed on such work, whether by subcontractor or otherwise, at not less than the prevailing hourly rate of wages for work of a similar character (exclusive of maintenance work) in the locality in which the work is performed and not less than the prevailing hourly rate of wages for legal holiday and overtime work (exclusive of maintenance work) in the locality in which the work is performed both as determined by the Department of Labor and Industrial Relations or determined by the Court of Appeal, as provided for in said contract and in any and all duly authorized modifications of said contract that may be hereafter made, with or without notice to the Surety, then, this obligation shall be void and of no effect, but it is expressly understood that if the Principal should make default in or should fail to strictly, faithfully and efficiently do, perform and comply with any or more of the covenants, agreements, stipulations, conditions, requirements or undertakings, as specified in or by the terms of said contract, and with the time therein named, then this obligation shall be valid and binding upon each of the parties hereto and this bond shall remain in full force and effect; and the same may be sued on at the instance of any material man, laborer, mechanic, subcontractor, individual, or otherwise to whom such payment is due, in the name of the State of Missouri, to the use of any such person.

AND, IT IS FURTHER specifically provided that any modifications which may hereinafter be made in the terms of the contract or in the work to be done under it or the giving by the Owner of any extension of the time for the performance of the contract or any other forbearance on the part of either the Owner or the Principal to the other, shall not in any way release the Principal and the Surety, or either or any of them, their heirs, executors, administrators and successors, from their liability hereunder, notice to the Surety of any such extension, modifications or forbearance being hereby waived.

IN WITNESS WHEREOF, the above bounden parties have executed the within instrument this \_\_\_\_\_ day of \_\_\_\_\_, 20 \_\_\_\_.

**AS APPLICABLE:**

**AN INDIVIDUAL**

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

**A PARTNERSHIP**

Name of Partner: \_\_\_\_\_

Signature of Partner: \_\_\_\_\_

Name of Partner: \_\_\_\_\_

Signature of Partner: \_\_\_\_\_

**CORPORATION**

Firm Name: \_\_\_\_\_

Signature of President: \_\_\_\_\_

**SURETY**

Surety Name: \_\_\_\_\_

Attorney-in-Fact: \_\_\_\_\_

Address of Attorney-in-Fact: \_\_\_\_\_

Telephone Number of Attorney-in-Fact: \_\_\_\_\_

Signature Attorney-in-Fact: \_\_\_\_\_

**NOTE:** Surety shall attach Power of Attorney



STATE OF MISSOURI  
 OFFICE OF ADMINISTRATION  
 DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION  
**PRODUCT SUBSTITUTION REQUEST**

PROJECT NUMBER

PROJECT TITLE AND LOCATION

CHECK APPROPRIATE BOX

**SUBSTITUTION PRIOR TO BID OPENING**  
 (Minimum of (5) working days prior to receipt of Bids as per Article 4 – Instructions to Bidders)

**SUBSTITUTION FOLLOWING AWARD**  
 (Maximum of (20) working days from Notice to Proceed as per Article 3 – General Conditions)

FROM: BIDDER/CONTRACTOR (PRINT COMPANY NAME)

TO: ARCHITECT/ENGINEER (PRINT COMPANY NAME)

Bidder/Contractor hereby requests acceptance of the following product or systems as a substitution in accordance with provisions of Division One of the Bidding Documents:

SPECIFIED PRODUCT OR SYSTEM

SPECIFICATION SECTION NO.

SUPPORTING DATA

Product data for proposed substitution is attached (include description of product, standards, performance, and test data)

Sample                       Sample will be sent, if requested

**QUALITY COMPARISON**

	SPECIFIED PRODUCT	SUBSTITUTION REQUEST
NAME, BRAND		
CATALOG NO.		
MANUFACTURER		
VENDOR		

**PREVIOUS INSTALLATIONS**

PROJECT	ARCHITECT/ENGINEER
LOCATION	DATE INSTALLED

**SIGNIFICANT VARIATIONS FROM SPECIFIED PRODUCT**

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**REASON FOR SUBSTITUTION**

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**DOES PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK?**

YES     NO

IF YES, EXPLAIN

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**SUBSTITUTION REQUIRES DIMENSIONAL REVISION OR REDESIGN OF STRUCTURE OR A/E WORK**

YES     NO

**BIDDER'S/CONTRACTOR'S STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENT:**

We have investigated the proposed substitution. We believe that it is equal or superior in all respects to specified product, except as stated above; that it will provide the same Warranty as specified product; that we have included complete implications of the substitution; that we will pay redesign and other costs caused by the substitution which subsequently become apparent; and that we will pay costs to modify other parts of the Work as may be needed, to make all parts of the Work complete and functioning as a result of the substitution.

BIDDER/CONTRACTOR

DATE

**REVIEW AND ACTION**

Resubmit Substitution Request with the following additional information:

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Substitution is accepted.

Substitution is accepted with the following comments:

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Substitution is not accepted.

ARCHITECT/ENGINEER

DATE



PROJECT NUMBER
----------------

KNOW ALL MEN BY THESE PRESENT THAT:                    hereinafter called "Subcontractor" who heretofore entered into an agreement with                    hereinafter called "Contractor", for the performance of work and/or furnishing of material for the construction of the project entitled

(PROJECT TITLE, PROJECT LOCATION, AND PROJECT NUMBER)

at  
 \_\_\_\_\_  
 (ADDRESS OF PROJECT)

for the State of Missouri (Owner) which said subcontract is by this reference incorporated herein, in consideration of such final payment by Contractor.

DOES HEREBY:

1. ACKNOWLEDGE that they have been **PAID IN FULL** all sums due for work and materials contracted or done by their Subcontractors, Material Vendors, Equipment and Fixture Suppliers, Agents and Employees, or otherwise in the performance of the Work called for by the aforesaid Contract and all modifications or extras or additions thereto, for the construction of said project or otherwise.
2. RELEASE and fully, finally, and forever discharge the Owner from any and all suits, actions, claims, and demands for payment for work performed or materials supplied by Subcontractor in accordance with the requirements of the above referenced Contract.
1. REPRESENT that all of their Employees, Subcontractors, Material Vendors, Equipment and Fixture Suppliers, and everyone else has been **paid in full** all sums due them, or any of them, in connection with performance of said Work, or anything done or omitted by them, or any of them in connection with the construction of said improvements, or otherwise.

DATED this            day of            , 20    .

NAME OF SUBCONTRACTOR
-----------------------

BY (TYPED OR PRINTED NAME)
----------------------------

SIGNATURE
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TITLE
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ORIGINAL: FILE/Closeout Documents



STATE OF MISSOURI  
 OFFICE OF ADMINISTRATION  
 DIVISION OF FACILITIES MANAGEMENT,  
 DESIGN AND CONSTRUCTION

**MBE/WBE/SDVE PROGRESS REPORT**

Remit with **ALL** Progress and Final Payments

(Please check appropriate box) CONSULTANT CONSTRUCTION

PAY APP NO.	PROJECT NUMBER
CHECK IF FINAL <input checked="" type="checkbox"/> <b>FINAL</b>	DATE

PROJECT TITLE

PROJECT LOCATION

FIRM

ORIGINAL CONTRACT SUM (Same as Line Item 1. on Form A of Application for Payment)  
\$

TOTAL CONTRACT SUM TO DATE (Same as Line Item 3. on Form A of Application for Payment)  
\$

THE TOTAL MBE/WBE/SDVE PARTICIPATION DOLLAR AMOUNT OF THIS PROJECT AS INDICATED IN THE ORIGINAL CONTRACT: \$

SELECT MBE, WBE, SDVE	ORIGINAL CONTRACT PARTICIPATION AMOUNT	PARTICIPATION AMOUNT PAID-TO-DATE (includes approved contract changes)	CONSULTANT/SUBCONSULTANT OR CONTRACTOR/SUBCONTRACTOR/SUPPLIER COMPANY NAME
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	
<input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SDVE	\$	\$	



## **INSTRUCTIONS FOR MBE/WBE/SDVE PROGRESS REPORT**

### **CONTRACTOR OR CONSULTANT TO FILL OUT AND REMIT WITH EACH PAY APPLICATION:**

The MBE/WBE/SDVE Progress Report for the project is issued with the contract comprising values reported in the consultant's Proposal or on the successful contractor's Section 004337 Compliance Evaluation Forms.

At Initial Pay Application fill in the following:

1. Pay App No. Start with 1.
2. Fill in the Project Number and Date.
3. Enter Project Title, Project Location, and Firm.
4. Fill in the "Original Contract Sum" and "Total Contract Sum To Date" (Reference applicable Line Items on Form A of Application for Payment).
5. Indicate the Total Participation Dollar Amount from the Original Contract.
6. Select MBE, WBE, or SDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier.
7. Enter the "Total Amount of Subcontract", "\$ Amount (Paid-To-Date)", and Company Name.

For all subsequent Pay Applications fill in the following:

1. Pay App No.
2. If Final Pay App, check box.
3. Fill in the Project Number and Date.
4. Enter Project Title, Project Location, and Firm
5. At each Pay App fill in the "Original Contract Sum" and "Total Contract Sum To Date" (reference applicable Line Items on Form A of Application for Payment).
6. Indicate the Total Participation Dollar Amount from the Original Contract.
7. Select MBE, WBE, or SDVE for each Consultant/Subconsultant or Contractor/Subcontractor/Supplier
8. Enter the "Total Amount of Subcontract", "\$ Amount (Paid-To-Date)", and Company Name.



STATE OF MISSOURI  
 OFFICE OF ADMINISTRATION  
 DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION  
**AFFIDAVIT – COMPLIANCE WITH PREVAILING WAGE LAW**

PROJECT NUMBER
----------------

Before me, the undersigned Notary Public, in and for the County of \_\_\_\_\_

State of \_\_\_\_\_ personally came and appeared \_\_\_\_\_

(NAME)

\_\_\_\_\_ of the \_\_\_\_\_

(POSITION) (NAME OF THE COMPANY)

(a corporation) (a partnership) (a proprietorship) and after being duly sworn did depose and say that all provisions and requirements set out in Chapter 290, Sections 290.210 through and including 290.340, Missouri Revised Statutes, pertaining to the payment of wages to workmen employed on public works project have been fully satisfied and there has been no exception to the full and completed compliance with said provisions and requirements and with Wage Determination No: \_\_\_\_\_ issued by the Department of Labor and Industrial Relations, State of Missouri on the \_\_\_\_\_ day of \_\_\_\_\_ 20 \_\_\_\_\_ in carrying out the contract and working in connection with \_\_\_\_\_

(NAME OF PROJECT)

Located at \_\_\_\_\_ in \_\_\_\_\_ County

(NAME OF THE INSTITUTION)

Missouri, and completed on the \_\_\_\_\_ day of \_\_\_\_\_ 20 \_\_\_\_\_

SIGNATURE

**NOTARY INFORMATION**

NOTARY PUBLIC EMBOSSEER OR BLACK INK RUBBER STAMP SEAL	STATE	COUNTY (OR CITY OF ST. LOUIS)
	SUBSCRIBED AND SWORN BEFORE ME, THIS	
	DAY OF	YEAR
	NOTARY PUBLIC SIGNATURE	MY COMMISSION EXPIRES
NOTARY PUBLIC NAME (TYPED OR PRINTED)		<b>USE RUBBER STAMP IN CLEAR AREA BELOW</b>

FILE: Closeout Documents

# GENERAL CONDITIONS

## INDEX

### ARTICLE:

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- 1.6. Patents and Royalties
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- 5.2. Project Construction
- 5.3. Project Completion
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#### 6. Bond and Insurance

#### 6.1. Bond

#### 6.2. Insurance

#### 7. Termination or Suspension of Contract

#### 7.1. For Site Conditions

#### 7.2. For Cause

#### 7.3. For Convenience

## SECTION 007213 - GENERAL CONDITIONS

- A. These General Conditions apply to each section of these specifications. The Contractor is subject to the provisions contained herein.
- B. The General Conditions are intended to define the relationship of the Owner, the Designer and the Contractor thereby establishing certain rules and provisions governing the operation and performance of the work so that the work may be performed in a safe, orderly, expeditious and workmanlike manner.

## ARTICLE 1 – GENERAL PROVISIONS

### ARTICLE 1.1 - DEFINITIONS

As used in these contract documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

- 1. **"COMMISSIONER"**: The Commissioner of the Office of Administration.
- 2. **"CONSTRUCTION DOCUMENTS"**: The "Construction Documents" shall consist of the Project Manual, Drawings and Addenda.
- 3. **"CONSTRUCTION REPRESENTATIVE:"** Whenever the term "Construction Representative" is used, it shall mean the Owner's Representative at the work site.
- 4. **"CONTRACTOR"**: Party or parties who have entered into a contract with the Owner to furnish work under these specifications and drawings.
- 5. **"DESIGNER"**: When the term "Designer" is used herein, it shall refer to the Architect, Engineer, or Consultant of Record specified and defined in Paragraph 2.0 of the Supplemental Conditions, or his duly authorized representative. The Designer may be either a consultant or state employee.
- 6. **"DIRECTOR"**: Whenever the term "Director" is used, it shall mean the Director of the Division of Facilities Management, Design and Construction or his Designee, representing the Office of Administration, State of Missouri. The Director is the agent of the Owner.
- 7. **"DIVISION"**: Shall mean the Division of Facilities Management, Design and Construction, State of Missouri.

- 8. **"INCIDENTAL JOB BURDENS"**: Shall mean those expenses relating to the cost of work, incurred either in the home office or on the job-site, which are necessary in the course of doing business but are incidental to the job. Such costs include office supplies and equipment, postage, courier services, telephone expenses including long distance, water and ice and other similar expenses.
- 9. **"JOINT VENTURE"**: An association of two (2) or more businesses to carry out a single business enterprise for profit for which purpose they combine their property, capital, efforts, skills and knowledge.
- 10. **"OWNER"**: Whenever the term "Owner" is used, it shall mean the State of Missouri.
- 11. **"PROJECT"**: Wherever the term "Project" is used, it shall mean the work required to be completed by the construction contract.
- 12. **"PROJECT MANUAL"**: The "Project Manual" shall consist of Introductory Information, Invitation for Bid, Instructions to Bidders, Bid Documents, Additional Information, Standard Forms, General Conditions, Supplemental General Conditions, General Requirements and Technical Specifications.
- 13. **"SUBCONTRACTOR"**: Party or parties who contract under, or for the performance of part or this entire Contract between the Owner and Contractor. The subcontract may or may not be direct with the Contractor.
- 14. **"WORK"**: Labor, material, supplies, plant and equipment required to perform and complete the service agreed to by the Contractor in a safe, expeditious, orderly and workmanlike manner so that the project shall be complete and finished in the best manner known to each respective trade.
- 15. **"WORKING DAYS"**: are all calendar days except Saturdays, Sundays and the following holidays: New Year's Day, Martin Luther King, Jr. Day, Lincoln Day, Washington's Birthday (observed), Truman Day, Memorial Day, Juneteenth, Independence Day, Labor Day, Columbus Day, Veterans Day (observed), Thanksgiving Day, Christmas Day.

### ARTICLE 1.2 DRAWINGS AND SPECIFICATIONS

- A. In case of discrepancy between drawings and specifications, specifications shall govern. Should discrepancies in architectural drawings, structural drawings and mechanical drawings occur,

architectural drawings shall govern and, in case of conflict between structural and mechanical drawings, structural drawings shall govern.

- B. Specifications are separated into titled divisions for convenience of reference only and to facilitate letting of contracts and subcontracts. The Contractor is responsible for establishing the scope of work for subcontractors, which may cross titled divisions. Neither the Owner nor Designer will establish limits and jurisdiction of subcontracts.
- C. Figured dimensions take precedence over scaled measurements and details over smaller scale general drawings. In the event of conflict between any of the documents contained within the contract, the documents shall take precedence and be controlling in the following sequence: addenda, supplementary general conditions, general conditions, division 1 specifications, technical division specifications, drawings, bid form and instructions to bidders.
- D. Anything shown on drawings and not mentioned in these specifications or vice versa, as well as any incidental work which is obviously necessary to complete the project within the limits established by the drawings and specifications, although not shown on or described therein, shall be performed by the Contractor at no additional cost as a part of his contract.
- E. Upon encountering conditions differing materially from those indicated in the contract documents, the Contractor shall promptly notify the Designer and Construction Representative in writing before such conditions are disturbed. The Designer shall promptly investigate said conditions and report to the Owner, with a recommended course of action. If conditions do materially differ and cause an increase or decrease in contract cost or time required for completion of any portion of the work, a contract change will be initiated as outlined in Article 4 of these General Conditions.
- E. Only work included in the contract documents is authorized, and the Contractor shall do no work other than that described therein or in accordance with appropriately authorized and approved contract changes.

#### **ARTICLE 1.3 - COMPLIANCE WITH LAWS, PERMITS, REGULATIONS AND INSPECTIONS**

- A. Since the Owner is the State of Missouri, municipal or political subdivisions, zoning ordinances, construction codes (other than licensing of trades), and other like ordinances are not applicable to construction on Owner's property, and Contractor will not be required to submit drawings and specifications to any municipal or political subdivision, authority, obtain

construction permits or any other licenses (other than licensing of trades) or permits from or submit to inspections by any municipality or political subdivision relating to the construction for this project. All permits or licenses required by municipality or political subdivision for operation on property not belonging to Owner shall be obtained by and paid for by Contractor. Each Contractor shall comply with all applicable laws, ordinances, rules and regulations that pertain to the work of this contract.

- B. Contractors, subcontractors and their employees engaged in the businesses of electrical, mechanical, plumbing, carpentry, sprinkler system work, and other construction related trades shall be licensed to perform such work by the municipal or political subdivision where the project is located, if such licensure is required by local code. Local codes shall dictate the level (master, journeyman, and apprentice) and the number, type and ratio of licensed tradesmen required for this project within the jurisdiction of such municipal or political subdivision.
- C. Equipment and controls manufacturers and their authorized service and installation technicians that do not maintain an office within the jurisdiction of the municipal or political subdivision but are a listed or specified contractor or subcontractor on this project are exempt from Paragraph 1.3 B above.
- D. The Contractor shall post a copy of the wage determination issued for the project and included as a part of the contract documents, in a prominent and easily accessible location at the site of construction for the duration of the project.
- E. Any contractor or subcontractor to such contractor at any tier signing a contract to work on this project shall provide a ten-hour Occupational Safety and Health Administration (OSHA) construction safety program for their on-site employees which includes a course in construction safety and health approved by OSHA or a similar program approved by the Department of Labor and Industrial Relations which is at least as stringent as an approved OSHA program. The contractor shall forfeit as a penalty to the public body on whose behalf the contract is made or awarded, two thousand five hundred dollars plus one hundred dollars for each employee employed by the contractor or subcontractor, for each calendar day, or portion thereof, such employee is employed without the required training.

#### **ARTICLE 1.4 - NONDISCRIMINATION IN EMPLOYMENT**

- A. The Contractor and his subcontractors will not discriminate against individuals based on race,

color, religion, national origin, sex, disability, or age, but may use restrictions which relate to bona fide occupational qualifications. Specifically, the Contractor and his subcontractors shall not discriminate:

1. Against recipients of service on the basis of race, color, religion, national origin, sex, disability or age.
2. Against any employee or applicant, for employment on the basis of race, color, religion, national origin, sex or otherwise qualified disability status.
3. Against any applicant for employment or employee on the basis of age, where such applicant or employee is between ages 40 and 70 and where such Contractor employs at least 20 persons.
4. Against any applicant for employment or employee on the basis of that person's status as a disabled or Vietnam-era veteran.

The Contractor and his Subcontractors will take affirmative action to insure applicants for employment and employees are treated equally without regard to race, color, religion, national origin, sex, disability, or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion and transfer; recruitment or recruitment advertising; and selection for training, including apprenticeship. The Contractor and his Subcontractors will give written notice of their commitments under this clause to any labor union with which they have bargaining or other agreements.

- B. The Contractor and his subcontractors shall develop, implement, maintain and submit in writing to the Owner an affirmative action program if at least fifty (50) persons in the aggregate are employed under this contract. If less than fifty (50) persons in the aggregate are to be employed under this contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed Affidavit for Affirmative Action in the form included in the contract specifications. For the purpose of this section, an "affirmative action program" means positive action to influence all employment practices (including, but not limited to, recruiting, hiring, promoting and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between age 40 and 70), disabled and Vietnam-era veteran status, and disability. Such "affirmative action program" shall include:
1. A written policy statement committing the total organization to affirmative action and

assigning management responsibilities and procedures for evaluation and dissemination;

2. The identification of a person designated to handle affirmative action;
3. The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion and discipline;
4. The exclusion of discrimination from all collective bargaining agreements; and
5. Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

In the enforcement of this non-discrimination clause, the Owner may use any reasonable procedures available, including, but not limited to: requests, reports, site visits and inspection of relevant documents of contractors and subcontractors.

- C. In the event of the Contractor's or his subcontractor's noncompliance with any provisions of this Article of the Contract, the Owner may cancel this contract in whole or in part or require the Contractor to terminate his contract with the subcontractor.

#### **ARTICLE 1.5 - ANTI-KICKBACK**

No employee of the division, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract or in any part hereof. No officer, employee, designer, attorney, or administrator of or for the Owner who is authorized in such capacity and on behalf of the Owner to exercise any legislative, executive, supervisory or other similar functions in connection with the construction of the project, shall have or acquire any pecuniary interest, whether direct or indirect, in this contract, any material supply contract, subcontract, insurance contract, or any other contract pertaining to the project.

#### **ARTICLE 1.6 - PATENTS AND ROYALTIES**

- A. The Contractor shall hold and save the Owner and its officers, agents, servants and employees harmless from liabilities of any nature or kind, including cost and expenses, for, or on account of, any patented or unpatented invention, process, article or appliance manufactured or used in the performance of this contract, including its use by the Owner, unless otherwise specifically stipulated in the contract documents.
- B. If the Contractor uses any design, device or materials covered by letters, patent or copyright,

the Contractor shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device or material. It is mutually agreed and understood, without exception, that the contract prices shall include all royalties or costs arising from the use of such design, device or materials, in any way involved in the work. The Contractor and/or his sureties shall indemnify and save harmless the Owner of the project from any and all claims for infringement by reason of the use of such patented or copyrighted design, device or materials or any trademark or copyright in connection with work agreed to be performed under this contract and shall indemnify the Owner for any cost, expense or damage it may be obliged to pay by reason of such infringement at any time during the prosecution of the work or after completion of the work.

#### **ARTICLE 1.7 - PREFERENCE FOR AMERICAN AND MISSOURI PRODUCTS AND SERVICES**

- A. By virtue of statutory authority a preference will be given to Missouri labor and to products of mines, forests and quarries of the state of Missouri when they are found in marketable quantities in the state, and all such materials shall be of the best quality and suitable character that can be obtained at reasonable market prices, all as provided for in Section 8.280, Missouri Revised Statutes and Cumulative Supplements.
- B. Furthermore, pursuant to Section 34.076 Missouri Revised Statutes and Cumulative Supplements, a preference shall be given to those persons doing business as Missouri firms, corporations, or individuals, or which maintain Missouri offices or places of business, when the quality of performance promised is equal or better and the price quoted is the same or less. In addition, in order for a non-domiciliary bidder to be successful, his bid must be that same percentage lower than a domiciliary Missouri bidder's bid, as would be required for a Missouri bidder to successfully bid in the non-domiciliary state.
- C. In accordance with the Missouri Domestic Products Procurement Act Section 34.350 RSMo and Cumulative Supplements any manufactured goods or commodities used or supplied in the performance of this contract or any subcontract thereto shall be manufactured, assembled or produced in the United States, unless the specified products are not manufactured, assembled or produced in the United States in sufficient quantities to meet the agency's requirements or cannot be manufactured, assembled or produced in the United States within the necessary time in sufficient quantities to meet the contract requirements, or if obtaining the specified products manufactured, assembled or produced in the

United States would increase the cost of this contract for purchase of the product by more than ten percent.

#### **ARTICLE 1.8 - COMMUNICATIONS**

- A. All notices, requests, instructions, approvals and claims must be in writing and shall be delivered to the Designer and copied to the Construction Representative for the project except as required by Article 1.12 Disputes and Disagreements, or as otherwise specified by the Owner in writing as stated in Section 012600. Any such notice shall be deemed to have been given as of the time of actual receipt.
- B. The Contractor shall attend on-site progress and coordination meetings, as scheduled by the Construction Representative, no less than once a month.
- C. The Contractor shall ensure that major subcontractors and suppliers shall attend monthly progress meetings as necessary to coordinate the work, and as specifically requested by the Construction Representative.

#### **ARTICLE 1.9 - SEPARATE CONTRACTS AND COOPERATION**

- A. The Owner reserves the right to let other contracts in connection with this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.
- B. The Contractor shall consult the drawings for all other contractors in connection with this work. Any work conflicting with the above shall be brought to the attention of the Owner's Representative before the work is performed. If the Contractor fails to do this, and constructs any work which interferes with the work of another contractor, the Contractor shall remove any part so conflicting and rebuild same, as directed by the Owner's Representative at no additional cost to the Owner.
- C. Each contractor shall be required to coordinate his work with other contractors so as to afford others reasonable opportunity for execution of their work. No contractor shall delay any other contractor by neglecting to perform contract work at the proper time. If any contractor causes delay to another, they shall be liable directly to that contractor for such delay in addition to any liquidated damages which might be due the Owner.
- D. Should the Contractor or project associated subcontractors refuse to cooperate with the instructions and reasonable requests of other Contractors or other subcontractors in the overall

coordinating of the work, the Owner may take such appropriate action and issue directions, as required, to avoid unnecessary and unwarranted delays.

- E. Each Contractor shall be responsible for damage done to Owner's or other Contractor's property by him/her or workers in his employ through their fault or negligence.
- F. Should a Contractor sustain any damage through any act or omission of any other Contractor having a contract with the Owner, the Contractor so damaged shall have no claim or cause of action against the Owner for such damage, but shall have a claim or cause of action against the other Contractor to recover any and all damages sustained by reason of the acts or omissions of such Contractor. The phrase "acts or omissions" as used in this section shall be defined to include, but not be limited to, any unreasonable delay on the part of any such contractors.

#### **ARTICLE 1.10 - ASSIGNMENT OF CONTRACT**

- A. No assignment by Contractor of any amount or any part of this contract or of the funds to be received there under will be recognized unless such assignment has had the written approval of the Director and the surety has been given due notice of such assignment and has furnished written consent thereto. In addition to the usual recitals in assignment contracts, the following language must be set forth: "It is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of this contract and to claims or liens for services rendered or materials supplied for the performance of the work called for in said contract in favor of all persons, firms or corporations rendering such services or supplying such materials."

#### **ARTICLE 1.11 - INDEMNIFICATION**

- A. Contractor agrees to indemnify and save harmless Owner and its respective commissioners, officers, officials, agents, consultants and employees and Designer, their agents, servants and employees, from and against any and all liability for damage arising from injuries to persons or damage to property occasioned by any acts or omissions of Contractor, any subcontractors, agents, servants or employees, including any and all expense, legal or otherwise, which may be incurred by Owner or Designer, its agents, servants or employees, in defense of any claim, action or suit.
- B. The obligations of the Contractor under this paragraph shall not extend to the liability of the Designer, his agents or employees, arising out of (1) the preparation or approval of maps, drawings, opinions, reports, surveys, contract changes, design or specifications, or (2) giving of or the failure to

give directions or instructions by the Designer, his agents or employees as required by this contract documents provided such giving or failure to give is the primary cause of the injury or damage.

#### **ARTICLE 1.12 - DISPUTES AND DISAGREEMENTS**

It is hereby expressly agreed and understood that in case any controversy or difference of opinion arises during construction, best efforts will be given to resolution at the field level. Should those efforts be unsuccessful, the Contractor has the right to appeal in writing, the decision of the Director's Designee to the Director at Room 730 Truman Building, P.O. Box 809, Jefferson City, Missouri 65102. The decision of the Director shall be final and binding on all parties.

#### **ARTICLE 2 -- OWNER/DESIGNER RESPONSIBILITIES**

- A. The Owner shall give all orders and directions contemplated under this contract relative to the execution of the work. During progress of work the Owner will be represented at the project site by the Construction Representative and/or Designer, whose responsibilities are to see that this contract is properly fulfilled.
- B. The Owner shall at all times have access to the work whenever it is in preparation or progress. The Contractors shall provide proper facilities for such access and for inspection and supervision.
- C. All materials and workmanship used in the work shall be subject to the inspection of the Designer and Construction Representative, and any work which is deemed defective shall be removed, rebuilt or made good immediately upon notice. The cost of such correction shall be borne by the Contractor. Contractor shall not be entitled to an extension of the contract completion date in order to remedy defective work. All rejected materials shall be immediately removed from the site of the work.
- D. If the Contractor fails to proceed at once with the correction of rejected defective materials or workmanship, the Owner may, by separate contract or otherwise, have the defects remedied or rejected. Materials removed from the site and charge the cost of the same against any monies which may be due the Contractor, without prejudice to any other rights or remedies of the Owner.
- E. Failure or neglect on the part of Owner to observe faulty work, or work done which is not in accordance with the drawings and specifications shall not relieve the Contractor from responsibility



for correcting such work without additional compensation.

- F. The Owner shall have the right to direct the Contractor to uncover any completed work.
  - 1. If the Contractor fails to adequately notify the Construction Representative and/or Designer of an inspection as required by the Contract Documents, the Contractor shall, upon written request, uncover the work. The Contractor shall bear all costs associated with uncovering and again covering the work exposed.
  - 2. If the Contractor is directed to uncover work, which was not otherwise required by the Contract Documents to be inspected, and the work is found to be defective in any respect, no compensation shall be allowed for this work. If, however, such work is found to meet the requirements of this contract, the actual cost of labor and material necessarily involved in the examination and replacement plus 10% shall be allowed the Contractor.
- G. The Designer shall give all orders and directions contemplated under this contract relative to the scope of the work and shall give the initial interpretation of the contract documents.
- H. The Owner may file a written notice to the Contractor to dismiss immediately any subcontractors, project managers, superintendents, foremen, workers, watchmen or other employees whom the Owner may deem incompetent, careless or a hindrance to proper or timely execution of the work. The Contractor shall comply with such notice as promptly as practicable without detriment to the work or its progress.
- I. If in the Owner's judgment it becomes necessary at any time to accelerate work, when ordered by the Owner in writing, the Contractor shall redirect resources to such work items and execute such portions of the work as may be required to complete the work within the current approved contract schedule.

### **ARTICLE 3 -- CONTRACTOR RESPONSIBILITIES**

The Contractor shall register and utilize the Owner's eBuilder digital project management system for submission of documents described in the following sections. This includes but is not limited to submittals as required by designer, payment applications, Request for Information (RFI), construction change orders, Request for Proposals (RFP), Designer Supplemental Instructions (DSI), etc.

### **ARTICLE 3.1 -- ACCEPTABLE SUBSTITUTIONS**

- A. The Contractor may request use of any article, device, product, material, fixture, form or type of construction which in the judgment of the Owner and Designer is equal in all respects to that named. Standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner and Designer that they are equal in design, strength, durability, usefulness and convenience for the purpose intended.
- B. Any changes required in the details and dimensions indicated on the drawings for the substitution of products other than those specified shall be properly made at the expense of the Contractor requesting the substitution or change.
- C. The Contractor shall submit a request for such substitutions in writing to the Owner and Designer within twenty (20) working days after the date of the "Notice to Proceed." Thereafter no consideration will be given to alternate forms of accomplishing the work. This Article does not preclude the Owner from exercising the provisions of Article 4 hereof.
- D. Any request for substitution by the Contractor shall be submitted in accordance with SECTION 002113 - INSTRUCTIONS TO BIDDERS.
- E. When a material has been approved, no change in brand or make will be permitted unless:
  - 1. Written verification is received from the manufacturer stating they cannot make delivery on the date previously agreed, or
  - 2. Material delivered fails to comply with contract requirements.

### **ARTICLE 3.2 -- SUBMITTALS**

- A. The Contractor's submittals must be submitted with such promptness as to allow for review and approval so as not to cause delay in the work. The Contractor shall coordinate preparation and processing of submittals with performance of construction activities.

Coordinate each submittal with fabrication, = purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

Submit four (4) copies to the Designer and additional copies as required for the subcontractors and material suppliers. Also provide copies to meet the requirements for maintenance manuals.

- B. All subcontractors' shop drawings and schedules shall be submitted by the Contractor and shall bear evidence that Contractor has received, reviewed, and approved them. Any shop drawings and

schedules submitted without this evidence will be returned to the Contractor for resubmission.

- C. The Contractor shall include with the shop drawing, a letter indicating any and all deviations from the drawings and/or specifications. Failure to notify the Designer of such deviations will be grounds for subsequent rejection of the related work or materials. If, in the opinion of the Designer, the deviations are not acceptable, the Contractor will be required to furnish the item as specified and indicated on the drawings.
- D. The Designer shall check shop drawings and schedules with reasonable promptness and approve them only if they conform to the design concept of the project and comply with the information given in the contract documents. The approval shall not relieve the Contractor from the responsibility to comply with the drawings and specifications, unless the Contractor has called the Designer's attention to the deviation, in writing, at the time of submission and the Designer has knowingly approved thereof. An approval of any such modification will be given only under the following conditions:
  - 1. It is in the best interest of the Owner
  - 2. It does not increase the contract sum and/or completion time
  - 3. It does not deviate from the design intent
  - 4. It is without prejudice to any and all rights under the surety bond.
- E. No extension of time will be granted because of the Contractor's failure to submit shop drawings and schedules in ample time to allow for review, possible resubmission, and approval. Fabrication of work shall not commence until the Contractor has received approval. The Contractor shall furnish prints of approved shop drawings and schedules to all subcontractors whose work is in any way related to the work under this contract. Only prints bearing this approval will be allowed on the site of construction
- F. The Contractor shall maintain a complete file on-site of approved shop drawings available for use by the Construction Representative.

### **ARTICLE 3.3 – AS-BUILT DRAWINGS**

- A. The Contractor shall update a complete set of the construction drawings, shop drawings and schedules of all work monthly by marking changes, and at the completion of their work (prior to submission of request for final payment) note all changes and turn the set over to the Construction Representative. The updates shall show all addenda, all field changes that were made to adapt to field conditions, changes resulting from contract

changes or supplemental instructions, and all locations of structures, buried installations of piping, conduit, and utility services. All buried and concealed items both inside and outside shall be accurately located as to depth and referenced to permanent features such as interior or exterior wall faces and dimensions shall be given in a neat and legible manner in a contrasting colored pencil or ink. If approved by the Designer, an electronic file format may be provided.

### **ARTICLE 3.4 – GUARANTY AND WARRANTIES**

#### **A. General Guaranty**

- 1. Neither the final certificate of payment nor any provision in the contract documents nor partial use or occupancy of the premises by the Owner shall constitute an acceptance of work not done in accordance with contract requirements.
- 2. The Contractor or surety shall remedy any defects in the work and pay for any damage to property resulting there from which shall appear within a period of one (1) year from the date of substantial completion unless a longer period is otherwise specified or a differing guaranty period has been established in the substantial completion certificate. The Owner will give notice of observed defects with reasonable promptness.
- 3. In case of default on the part of the Contractor in fulfilling this part of this contract, the Owner may correct the work or repair the damage and the cost and expense incurred in such event shall be paid by or recoverable from the Contractor or surety.
- 4. The work will be free from defects not inherent in the quality required or permitted, and that the Work will conform to the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Contractor's guaranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment

#### **B. Extended Warranty**

Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year. Where a longer

period is offered at no additional cost or called for in the specific equipment specifications, the longer period shall govern.

### **ARTICLE 3.5 -- OPERATION AND MAINTENANCE MANUALS**

A. Immediately after equipment submittals are approved and no later than ten (10) working days prior to the substantial completion inspection, the Contractor shall provide to the Designer three (3) copies of operating instructions and service manuals, containing the following:

1. Start-up and Shut-down Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available; they may be incorporated into the operating manual for reference.
2. Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.
3. Equipment List: List of all major equipment as installed shall be prepared to include model number, capacities, flow rate, name place data, shop drawings and air and water balance reports.
4. Service Instructions: Provide the following information for all pieces of equipment.
  - a. Recommended spare parts including catalog number and name of local supplier or factory representative.
  - b. Belt sizes, types, and lengths.
  - c. Wiring diagrams.
5. Manufacturer's Certificate of Warranty as described in Article 3.4.
6. Prior to the final payment, furnish to the Designer three (4) copies of parts catalogs for each piece of equipment furnished by him/her on the project with the components identified by number for replacement ordering.

B. Submission of operating instructions shall be done in the following manner.

1. Manuals shall be in quadruplicate, and all materials shall be bound into volumes of standard 8½" x 11" hard binders. Large drawings too bulky to be folded into 8½" x 11" shall be separately bound or folded and in envelopes, cross referenced and indexed with the manuals.
2. The manuals shall identify project name, project number, and include the name and

address of the Contractor, subcontractors and manufacturers who were involved with the activity described in that particular manual.

3. Internally subdivide the binder contents with permanent page dividers, logically organized with tab titles clearly printed under reinforced laminated plastic tabs.
4. Contents: Prepare a Table of Contents for each volume, with each product or system description identified.

### **ARTICLE 3.6 – OTHER CONTRACTOR RESPONSIBILITIES**

- A. The Contractor shall keep on site, during progress of the work, a competent superintendent satisfactory to the Construction Representative. The superintendent shall represent the Contractor and all agreements made by the superintendent shall be binding. The superintendent shall carefully study and compare all drawings, specifications and other instructions and shall promptly notify the Construction Representative and Designer, in writing, any error, inconsistency or omission which may be discovered. The superintendent shall coordinate all work on the project. Any change of the superintendent shall be approved by the Construction Representative.
- B. Contractor shall, at all times, enforce strict discipline and good order among his employees, and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him/her.
- C. The Contractor shall supply sufficient labor, material, plant and equipment and pay when due any laborer, subcontractor or supplier for supplies furnished and otherwise prosecute the work with diligence to prevent work stoppage and insure completion thereof within the time specified.
- D. The Contractor and each of his subcontractors shall submit to the Construction Representative, through the Designer such schedules of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data as the Owner may request concerning work performed or to be performed under this contract.
- E. The Contractor, subcontractors, and material suppliers shall upon written request, give the Owner access to all time cards, material invoices, payrolls, estimates, profit and loss statements, and all other direct or indirect costs related to this work.
- F. The Contractor shall be responsible for laying out all contract work such as layout of architectural, structural, mechanical and electrical work, which shall be coordinated with layouts of subcontractors

for general construction work. The Contractor is also responsible for unloading, uncrating and handling of all materials and equipment to be erected or placed by him/her, whether furnished by Contractor or others. No extra charges or compensation will be allowed as a result of failure to verify dimensions before ordering materials or fabricating items.

- G. The Contractor must notify the Construction Representative at least one working day before placing concrete or burying underground utilities, pipelines, etc.
- H. Contractors shall prearrange time with the Construction Representative for the interruption of any facility operation. Unless otherwise specified in these documents, all connections, alterations or relocations as well as all other portions of the work will be performed during normal working hours.
- I. The Contractor shall coordinate all work so there will not be prolonged interruptions of existing equipment operation. Any existing plumbing, heating, ventilating, air conditioning or electrical disconnections necessary for the project, which affect portions of this construction or building or any other building must be scheduled with the Construction Representative to minimize or avoid any disruption of facility operations. In no case, unless previously approved in writing by the Construction Representative, shall utilities be left disconnected at the end of a work day or over a weekend. Any interruption of utilities either intentionally or accidentally shall not relieve the Contractor responsible for the interruption from the responsibility to repair and restore the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.
- J. Contractors shall limit operations and storage of materials to the area within the project, except as necessary to connect to existing utilities, and shall not encroach on neighboring property. The Contractor shall be responsible for repair of their damage to property on or off the project site occurring during construction of project. All such repairs shall be made to the satisfaction of the property owner.
- K. Unless otherwise permitted, all materials shall be new and both workmanship and materials shall be of the best quality.
- L. Unless otherwise provided and stipulated within these specifications, the Contractor shall furnish, construct, and/or install and pay for materials, devices, mechanisms, equipment, all necessary personnel, utilities including, but not limited to water, heat, light and electric power, transportation

services, applicable taxes of every nature, and all other facilities necessary for the proper execution and completion of the work.

- M. Contractor shall carefully examine the plans and drawings and shall be responsible for the proper fitting of his material, equipment and apparatus into the building.
- N. The Contractor or subcontractors shall not overload, or permit others to overload, any part of any structure during the performance of this contract.
- O. All temporary shoring, bracing, etc., required for the removal of existing work and/or for the installation of new work shall be included in this contract. The Contractor shall make good, at no cost to the Owner, any damage caused by improper support or failure of shoring in any respect. Each Contractor shall be responsible for shoring required to protect his work or adjacent property and improvements of Owner and shall be responsible for shoring or for giving written notice to adjacent property owners. Shoring shall be removed only after completion of permanent supports.
- P. The Contractor shall provide at the proper time such material as is required for support of the work. If openings are required, whether shown on drawings or not, the Contractor shall see that they are properly constructed.
- Q. During the performance of work the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences and other devices appropriately located on site which will give proper and understandable warning to all persons of danger of entry onto land, structure or equipment.
- R. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials.
- S. The Contractor shall be responsible for care of the finished work and shall protect same from damage or defacement until substantial completion by the Owner. If the work is damaged by any cause, the Contractor shall immediately begin to make repairs in accordance with the drawings and specifications. Contractor shall be liable for all damage or loss unless attributable to the acts or omissions of the Owner or Designer. Any claim for reimbursement shall be submitted in accordance with Article 4. After substantial completion the Contractor will only be responsible for damage resulting from acts or omissions of the Contractor or subcontractors through final warranty.
- T. In the event the Contractor encounters an unforeseen hazardous material, the Contractor

shall immediately stop work in the area affected and report the condition to the Owner and Designer in writing. The Contractor shall not be required, pursuant to Article 4, to perform, any work relating to hazardous materials.

- U. In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 4.
- V. Before commencing work, Contractors shall confer with the Construction Representative and facility representative and review any facility rules and regulations which may affect the conduct of the work.
- W. Project signs will only be erected on major projects and only as described in the specifications. If no sign is specified, none shall be erected.

#### **ARTICLE 3.7 -- SUBCONTRACTS**

- A. Subcontractor assignments as identified in the bid form shall not be changed without written approval of the Owner. The Owner will not approve changes of a listed subcontractor unless the Contractor documents, to the satisfaction of the Owner that the subcontractor cannot or will not perform the work as specified.
- B. The Contractor is fully responsible to the Owner for the acts and omissions of all subcontractors and of persons either directly or indirectly employed by them.
- C. Every subcontractor shall be bound by the applicable terms and provisions of these contract documents, but no contractual relationship shall exist between any subcontractor and the Owner unless the right of the Contractor to proceed with the work is suspended or this contract is terminated as herein provided, and the Owner in writing elects to assume the subcontract.
- D. The Contractor shall upon receipt of "Notice to Proceed" and prior to submission of the first payment request, notify the Designer and Construction Representative in writing of the names of any subcontractors to be used in addition to those identified in the bid form and all major material suppliers proposed for all parts of the work.

#### **ARTICLE 4 -- CHANGES IN THE WORK**

##### **4.1 CHANGES IN THE WORK**

- A. The Construction Representative, without giving notice to the surety and without invalidating this contract, may order extra work or make changes by

altering, adding to or deducting from the work, this contract sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract. A claim for extension of time caused by any change must be adjusted at the time of ordering such change. No future request for time will be considered.

- B. Each Contract Change shall include all costs required to perform the work including all labor, material, equipment, overheads and profit, delay, disruptions, or other miscellaneous expenses. No subsequent requests for additional compensation including claims for delay, disruption, or reduced efficiency as a result of each change will be considered. Values from the Schedule of Values will not be binding as a basis for additions to or deductions from the contract price.
- C. The amount of any adjustment in this contract price for authorized changes shall be agreed upon before such changes become effective and shall be determined, through submission of a request for proposal, as follows:
  - 1. By an acceptable fixed price proposal from the Contractor. Breakdowns shall include all takeoff sheets of each Contractor and subcontractor. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.
  - 2. By a cost-plus-fixed-fee (time and material) basis with maximum price, total cost not to exceed said maximum. Breakdown shall include a listing of each item of material with unit prices and number of hours of labor for each task. Labor costs per hour shall be included with labor burden identified, which shall be not less than the prevailing wage rate, etc. Overhead and profit shall be shown separately for each subcontractor and the Contractor.
  - 3. By unit prices contained in Contractor's original bid form and incorporated in the construction contract.
- D. Overhead and Profit on Contract Changes shall be applied as follows:

- 1. The overhead and profit charge by the Contractor and all subcontractors shall be considered to include, but is not limited to: incidental job burdens, small truck (under 1 ton) expense, mileage, small hand tools,

warranty costs, company benefits and general office overhead. Project supervision including field supervision and job site office expense shall be considered a part of overhead and profit unless a compensable time extension is granted.

2. The percentages for overhead and profit charged on Contract Changes shall be negotiated, and may vary according to the nature, extent, and complexity of the work involved. However, the overhead and profit for the Contractor or subcontractor actually performing the work shall not exceed 14%. When one or more tiers of subcontractors are used, in no event shall any Contractor or subcontractor receive as overhead and profit more than 3% of the cost of the work performed by any of his subcontractors. In no case shall the total overhead and profit paid by the Owner on any Contract Changes exceed twenty percent (20%) of the cost of materials, labor and equipment (exclusive of Contractor or any Subcontractor overhead and profit) necessary to put the contract change work in place.
  3. The Contractor will be allowed to add the cost of bonding and insurance to their cost of work. This bonding and insurance cost shall not exceed 2% and shall be allowed on the total cost of the added work, including overhead and profit.
  4. On proposals covering both increases and decreases in the amount of this contract, the application of overhead and profit shall be on the net change in the cost of the work.
  5. The percentage for overhead and profit to be credited to the Owner on Contract Changes that are solely decreases in the quantity of work or materials shall be negotiated, and may vary according to the nature, extent and complexity of the work involved, but in no case shall be less than ten percent (10%). If the percentage for overhead and profit charged for work added by Contract Changes for this contract has been negotiated to less than 10%, the negotiated rate shall then apply to credits as well.
- E. No claim for an addition to this contract sum shall be valid unless authorized as aforesaid in writing by the Owner. In the event that none of the foregoing methods are agreed upon, the Owner may order the Contractor to perform work on a time and material basis. The cost of such work shall be determined by the Contractor's actual labor and material cost to perform the work plus overhead and profit as outlined herein. The

Designer and Construction Representative shall approve the Contractor's daily time and material invoices for the work involved.

- F. If the Contractor claims that any instructions involve extra cost under this contract, the Contractor shall give the Owner's Representative written notice thereof within a reasonable time after the receipt of such instructions, and in any event before proceeding to execute the work. No such claim shall be valid unless so made and authorized by the Owner, in writing.
- G. In an emergency affecting the safety of life or of the structure or of adjoining property, the Contractor, without special instruction or authorization from the Construction Representative, is hereby permitted to act at their discretion to prevent such threatened loss or injury. The Contractor shall submit a claim for compensation for such emergency work in writing to the Owner's Representative.

#### **ARTICLE 4.2 – CHANGES IN COMPLETION TIME**

- A. Extension of the number of work days stipulated in the Contract for completion of the work with compensation may be made when:
  1. The contractor documents that proposed Changes in the work, as provided in Article 4.1, extends construction activities critical to contract completion date, OR
  2. The Owner suspends all work for convenience of the Owner as provided in Article 7.3, OR
  3. An Owner caused delay extends construction activities critical to contract completion (except as provided elsewhere in these General Conditions). The Contractor is to review the work activities yet to begin and evaluate the possibility of rescheduling the work to minimize the overall project delay.
- B. Extension of the number of work days stipulated in the Contract for completion of the work without compensation may be made when:
  1. Weather-related delays occur, subject to provisions for the inclusion of a specified number of "bad weather" days when provided for in Section 012100-Allowances, OR
  2. Labor strikes or acts of God occur, OR
  3. The work of the Contractor is delayed on account of conditions which were beyond the control of the Contractor, subcontractors or suppliers, and were not the result of their fault or negligence.
- C. No time extension or compensation will be provided for delays caused by or within the control

of the Contractor, subcontractors or suppliers and for concurrent delays caused by the Owner.

- D. The Contractor shall notify the Owner promptly of any occurrence or conditions which in the Contractor's opinion results in a need for an extension of time. The notice shall be in writing and shall include all necessary supporting materials with details of any resultant costs and be submitted in time to permit full investigation and evaluation of the Contractor's claim. The Owner shall promptly acknowledge the Contractor's notice and, after recommendation from the Owner's Representative and/or Designer, shall provide a decision to the Contractor. Failure on the part of the Contractor to provide such notice and to detail the costs shall constitute a waiver by the Contractor of any claim. Requests for extensions of time shall be for working days only.

## **ARTICLE 5 - CONSTRUCTION AND COMPLETION**

### **ARTICLE 5.1 – CONSTRUCTION COMMENCEMENT**

- A. Upon receipt of the "Intent to Award" letter, the Contractor must submit the following properly executed instruments to the Owner:
1. Contract;
  2. Performance/payment bond as described in Article 6.1;
  3. Certificates of Insurance, or the actual policies themselves, showing that the Contractor has obtained the insurance coverage required by Article 6.2.
  4. Written Affirmative Action Plans as required in Article 1.4.

Above referenced items must be received by the Owner within ten (10) working days after the effective date of the contract. If not received, the Owner may treat the failure to timely submit them as a refusal by the Contractor to accept a contract for this work and may retain as liquidated damages the Contractor's bid bond, cashier's check or certified check as provided in the Instructions to Bidders. Upon receipt the Owner will issue a "Notice to Proceed" with the work to the Contractor.

- B. Within the time frame noted in Section 013200 - Schedules, following receipt of the "Notice to Proceed", the Contractor shall submit to the Owner a progress schedule and schedule of values, showing activities through the end of the contract period. Should the Contractor not receive written notification from the Owner of the disapproval of the schedule of values within fifteen (15) working

days, the Contractor may consider it approved for purpose of determining when the first monthly Application and Certification for Payment may be submitted.

- C. The Contractor may commence work upon receipt of the Division of Facilities Management, Design and Construction's "Notice to Proceed" letter. Contractor shall prosecute the work with faithfulness and energy, and shall complete the entire work on or before the completion time stated in the contract documents or pay to the Owner the damages resulting from the failure to timely complete the work as set out within Article 5.4.

### **ARTICLE 5.2 -- PROJECT CONSTRUCTION**

- A. Each Contractor shall submit for the Owner's approval, in reproducible form, a progress schedule showing the rate of progress and the order of the work proposed to carry on various phases of the project. The schedule shall be in conformance with the requirements outlined in Section 013200 – Schedules.
- B. Contractor shall employ and supply a sufficient force of workers, material, and equipment and shall pay when due, any worker, subcontractor or supplier and otherwise prosecute the work with such diligence so as to maintain the rate of progress indicated on the progress schedule, prevent work stoppage, and insure completion of the project within the time specified.

### **ARTICLE 5.3 -- PROJECT COMPLETION**

- A. Substantial Completion. A Project is substantially complete when construction is essentially complete and work items remaining to be completed can be done without interfering with the Owner's ability to use the Project for its intended purpose.
1. Once the Contractor has reached what they believe is Substantial Completion, the Contractor shall notify the Designer and the Construction Representative of the following:
    - a. That work is essentially complete with the exception of certain listed work items. The list shall be referred to as the "Contractor's Punch."
    - b. That all Operation and Maintenance Manuals have been assembled and submitted in accordance with Article 3.5A.
    - c. That the Work is ready for inspection by the Designer and Construction Representative. The Owner shall be entitled to a minimum of ten working

days notice before the inspection shall be performed.

2. If the work is acceptable, the Owner shall issue a Certificate of Substantial Completion, which shall set forth the responsibilities of the Owner and the Contractor for utilities, security, maintenance, damage to the work and risk of loss. The Certificate shall also identify those remaining items of work to be performed by the Contractor. All such work items shall be complete within 30 working days of the date of the Certificate, unless the Certificate specifies a different time. If the Contractor shall be required to perform tests that must be delayed due to climatic conditions, it is understood that such tests and affected equipment will be identified on the Certificate and shall be accomplished by the Contractor at the earliest possible date. Performance of the tests may not be required before Substantial Completion can be issued. The date of the issuance of the Certificate of Substantial Completion shall determine whether or not the work was completed within the contract time and whether or not Liquidated Damages are due.
  3. If the work is not acceptable, and the Owner does not issue a Certificate of Substantial Completion, the Owner shall be entitled to charge the Contractor with the Designer's and Owner's costs of re-inspection, including time and travel.
- B. Partial Occupancy. Contractor agrees that the Owner shall be permitted to occupy and use any completed or partially completed portions of the Project, when such occupancy and use is in the Owner's best interest. Owner shall notify Contractor of its desire and intention to take Partial Occupancy as soon as possible but at least ten (10) working days before the Owner intends to occupy. If the Contractor believes that the portion of the work the Owner intends to occupy is not ready for occupancy, the Contractor shall notify the Owner immediately. The Designer shall inspect the work in accordance with the procedures above. If the Contractor claims increased cost of the project or delay in completion as a result of the occupancy, he shall notify the Owner immediately but in all cases before occupancy occurs.
- C. Final Completion. The Project is finally complete when the Certificate of Substantial Completion has been issued and all work items identified therein as incomplete have been completed, and when all administrative items required by the contract have been completed. Final Completion entitles the Contractor to payment of the outstanding balance of the contract amount including all change orders

and retainage. Within five (5) working days of the date of the Certificate of Substantial Completion, the Contractor shall identify the cost to complete any outstanding items of work. The Designer shall review the Contractor's estimate and either approve it or provide an independent estimate for all such items. If the Contractor fails to complete the remaining items within the time specified in the Certificate, the Owner may terminate the contract and go to the surety for project completion in accordance with Article 7.2 or release the contract balance to the Contractor less 150% of the approved estimate to complete the outstanding items. Upon completion of the outstanding items, when a final cost has been established, any monies remaining shall be paid to the Contractor. Failure to complete items of work does not relieve the Contractor from the obligation to complete the administrative requirements of the contract, such as the provisions of Article 5.3 FAILURE TO COMPLETE ALL ITEMS OF WORK UNDER THE CONTRACT SHALL BE CONSIDERED A DEFAULT AND BE GROUNDS FOR CONTRACT TERMINATION AND DEBARMENT.

- D. Liquidated Damages. Contractor agrees that the Owner may deduct from the contract price and retain as liquidated damages, and not as penalty or forfeiture, the sum stipulated in this contract for each work day after the Contract Completion Day on which work is not Substantially Complete. Assessment of Liquidated Damages shall not relieve the Contractor or the surety of any responsibility or obligation under the Contract. In addition, the Owner may, without prejudice to any other rights, claims, or remedies the Owner may have including the right to Liquidated Damages, charge the Contractor for all additional expenses incurred by the Owner and/or Designer as the result of the extended contract period through Final Completion. Additional Expenses shall include but not be limited to the costs of additional inspections.
- E. Early Completion. The Contractor has the right to finish the work before the contract completion date; however, the Owner assumes no liability for any hindrances to the Contractor unless Owner caused delays result in a time extension to the contract completion date. The Contractor shall not be entitled to any claims for lost efficiencies or for delay if a Certificate of Substantial Completion is given on or before the Contract Completion Date.

#### **ARTICLE 5.4 -- PAYMENT TO CONTRACTOR**

- A. Payments on account of this contract will be made monthly in proportion to the work which has been completed. Request for payment must be submitted on the Owner's forms. No other pay request will



be processed. Supporting breakdowns must be in the same format as Owner's forms and must provide the same level of detail. The Designer will, within 5 working days from receipt of the contractor's request for payment either issue a Certificate for Payment to the Owner, for such amount as the Designer determines is properly due, or notify the Contractor in writing of reasons for withholding a Certificate. The Owner shall make payment within 30 calendar days after the "Application and Certification for Payment" has been received and certified by the Designer. The following items are to be attached to the contractor's pay request:

1. Updated construction schedule
  2. Certified payrolls consisting of name, occupation and craft, number of hours worked and actual wages paid for each individual employee, of the Contractor and all subcontractors working on the project
- B. The Owner shall retain 5 percent of the amount of each such payment application, except as allowed by Article 5.4, until final completion and acceptance of all work covered by this contract.
- C. Each payment made to Contractor shall be on account of the total amount payable to Contractor and all material and work covered by paid partial payment shall thereupon become the sole property of Owner. This provision shall not be construed as relieving Contractor from sole responsibility for care and protection of materials and work upon which payments have been made or restoration of any damaged work or as a waiver of the right of Owner to require fulfillment of all terms of this contract.
- D. Materials delivered to the work site and not incorporated in the work will be allowed in the Application and Certification for Payment on the basis of one hundred (100%) percent of value, subject to the 5% retainage providing that they are suitably stored on the site or in an approved warehouse in accordance with the following requirements:
1. Material has previously been approved through submittal and acceptance of shop drawings conforming to requirements of Article 3.2 of General Conditions.
  2. Delivery is made in accordance with the time frame on the approved schedule.
  3. Materials, equipment, etc., are properly stored and protected from damage and deterioration and remain so - if not, previously approved amounts will be deleted from subsequent pay applications.

4. The payment request is accompanied by a breakdown identifying the material equipment, etc. in sufficient detail to establish quantity and value.
- E. The Contractor shall be allowed to include in the Application and Certification for Payment, one hundred (100%) of the value, subject to retainage, of major equipment and material stored off the site if all of the following conditions are met:
1. The request for consideration of payment for materials stored off site is made at least 15 working days prior to submittal of the Application for Payment including such material. Only materials inspected will be considered for inclusion on Application for Payment requests.
  2. Materials stored in one location off site are valued in excess of \$25,000.
  3. That a Certificate of Insurance is provided indicating adequate protection from loss, theft conversion or damage for materials stored off site. This Certificate shall show the State of Missouri as an additional insured for this loss.
  4. The materials are stored in a facility approved and inspected, by the Construction Representative.
  5. Contractor shall be responsible for, Owner costs to inspect out of state facilities, and any delays in the completion of the work caused by damage to the material or for any other failure of the Contractor to have access to this material for the execution of the work.
- F. The Owner shall determine the amount, quality and acceptability of the work and materials which are to be paid for under this contract. In the event any questions shall arise between the parties, relative to this contract or specifications, determination or decision of the Owner or the Construction Representative and the Designer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under this contract affected in any manner or to any extent by such question.
- G. Payments Withheld: The Owner may withhold or nullify in whole or part any certificate to such extent as may be necessary to protect the Owner from loss on account of:
1. Defective work not remedied. When a notice of noncompliance is issued on an item or items, corrective action shall be undertaken immediately. Until corrective action is completed, no monies will be paid and no additional time will be allowed for the item or

items. The cost of corrective action(s) shall be borne by the Contractor.

2. A reasonable doubt that this contract can be completed for the unpaid balance.
3. Failure of the Contractor to update as-built drawings monthly for review by the Construction Representative.
4. Failure of the Contractor to update the construction schedule.

When the Construction Representative is satisfied the Contractor has remedied above deficiencies, payment shall be released.

H. Final Payment: Upon receipt of written notice from the Contractor to the Designer and Project Representative that the work is ready for final inspection and acceptance, the Designer and Project Representative, with the Contractor, shall promptly make such inspection. If the work is acceptable and the contract fully performed, the Construction Representative shall complete a final acceptance report and the Contractor will be directed to submit a final Application and Certification for Payment. If the Owner approves the same, the entire balance shall be due and payable, with the exception of deductions as provided for under Article 5.4.

1. Where the specifications provide for the performance by the Contractor of (certain tests for the purpose of balancing and checking the air conditioning and heating equipment and the Contractor shall have furnished and installed all such equipment in accordance with the specifications, but said test cannot then be made because of climatic conditions, such test shall may be considered as required under the provisions of the specifications, Section 013300 and this contract may be substantial Full payment will not be made until the tests have been made and the equipment and system is finally accepted. If the tests are not completed when scheduled, the Owner may deduct 150% of the value of the tests from the final payment.
2. The final payment shall not become due until the Contractor delivers to the Construction Representative:
  - a) A complete file of releases, on the standard form included in the contract documents as "Final Receipt of Payment and Release Form", from subcontractors and material suppliers evidencing payment in full for services, equipment and materials, as the case may require, if the Owner approves, or a consent from

the Surety to final payment accepting liability for any unpaid amounts.

- b) An Affidavit of Compliance with Prevailing Wage Law, in the form as included in this contract specifications, properly executed by each subcontractor, and the Contractor
  - c) Certified copies of all payrolls
  - d) As-built drawings
3. If any claim remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such a claim including all costs and a reasonable attorney's fee.
  4. Missouri statute requires prompt payment from the Owner to the Contractor within thirty calendar days and from the Contractor to his subcontractors within fifteen calendar days. Failure to make payments within the required time frame entitles the receiving party to charge interest at the rate of one and one half percent per month calculated from the expiration of the statutory time period until paid.
  5. The value of all unused unit price allowances and/or 150% of the value of the outstanding work items, and/or liquidated damages may be deducted from the final pay request without executing a Contract Change. Any unit price items which exceed the number of units in the contract may be added by Contract Change.

## ARTICLE 6 -- INSURANCE AND BONDS

### ARTICLE 6.1 -- BOND

- A. Contractor shall furnish a performance/payment bond in an amount equal to 100% of the contract price to guarantee faithful performance of the contract and 100% of the contract price to guarantee the payment of all persons performing labor on the project and furnishing materials in connection therewith under this contract as set forth in the standard form of performance and payment bond included in the contract documents. The surety on such bond shall be issued by a surety company authorized by the Missouri Department of Insurance to do business in the state of Missouri.
- B. All Performance/Payment Bonds furnished in response to this provision shall be provided by a bonding company with a rating of B+ or higher as established by A.M. Best Company, Inc. in their most recent publication.

**ARTICLE 6.2 – INSURANCE**

- A. The successful Contractor shall procure and maintain for the duration of the contract issued a policy or policies of insurance for the protection of both the Contractor and the Owner and their respective officers, officials, agents, consultants and employees. The Owner requires certification of insurance coverage from the Contractor prior to commencing work.
- B. Minimum Scope and Extent of Coverage
  - 1. General Liability  
Commercial General Liability, ISO coverage form number or equivalent CG 00 01 ("occurrence" basis), or I-SO coverage form number CG 00 02, or ISO equivalent.  
  
If ISO equivalent or manuscript general liability coverage forms are used, minimum coverage will be as follows: Premises/Operations; Independent Contractors; Products/Completed Operations; personal Injury; Broad Form Property Damage including Completed Operations; Broad Form Contractual Liability Coverage to include Contractor's obligations under Article 1.11 Indemnification and any other Special Hazards required by the work of the contract.
  - 2. Automobile Liability  
Business Automobile Liability Insurance, ISO Coverage form number or equivalent CA 00 01 covering automobile liability, code 1 "ANY AUTO".
  - 3. Workers' Compensation and Employer's Liability  
Statutory Workers' Compensation Insurance for Missouri and standard Employer's Liability Insurance, or the authorization to self-insure for such liability from the Missouri Division of Workers' Compensation.
  - 4. Builder's Risk or Installation Floater Insurance  
Insurance upon the work and all materials, equipment, supplies, temporary structures and similar items which may be incident to the performance of the work and located at or adjacent to the site, against loss or damage from fire and such other casualties as are included in extended coverage in broad "All Risk" form, including coverage for Flood and Earthquake, in an amount not less than the replacement cost of the work or this contract price, whichever is greater, with loss payable to Contractor and Owner as their respective interests may appear.

Contractor shall maintain sufficient insurance to cover the full value of the work and materials as the work progresses, and shall furnish Owner copies of all endorsements. If Builder's Risk Reporting- Form of Endorsement is used, Contractor shall make all reports as required therein so as to keep in force an amount of insurance which will equal the replacement cost of the work, materials, equipment, supplies, temporary structures, and other property covered thereby; and if, as a result of Contractor's failure to make any such report, the amount of insurance so recoverable shall be less than such replacement cost, Contractor's interest in the proceeds of such insurance, if any, shall be subordinated to Owner's interest to the end that Owner may receive full reimbursement for its loss.

- C. Minimum Limits of Insurance
  - 1. General Liability  
Contractor  
\$2,000,000 combined single limit per occurrence for bodily injury, personal injury, and property damage  
\$2,000,000 annual aggregate
  - 2. Automobile Liability  
\$2,000,000 combined single limit per occurrence for bodily injury and property damage
  - 3. Workers' Compensation and Employers Liability  
Workers' Compensation limits as required by applicable State Statutes (generally unlimited) and minimum of \$1,000,000 limit per accident for Employer's Liability.  
  
General Liability and Automobile Liability insurance may be arranged under individual policies for the full limits required or by a combination of underlying policies with the balance provided by a form-following Excess or Umbrella Liability policy.
- D. Deductibles and Self-Insured Retentions  
All deductibles, co-payment clauses, and self-insured retentions must be declared to and approved by the Owner. The Owner reserves the right to request the reduction or elimination of unacceptable deductibles or self-insured retentions, as they would apply to the Owner, and their respective officers, officials, agents, consultants and employees. Alternatively, the Owner may request Contractor to procure a bond guaranteeing

payment of losses and related investigations, claims administration, and defense expenses.

E. Other Insurance Provisions and Requirements

The respective insurance policies and coverage, as specified below, must contain, or be endorsed to contain the following conditions or provisions:

1. General Liability

The Owner, and its respective commissioners, officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 Additional Insured - Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance of self-insurance programs maintained by the designated additional -insured's shall be excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's general liability insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner, or for any of their officers, officials, agents, consultants or employees.

2. Automobile Insurance

The Owner, and their respective officers, officials, agents, consultants and employees shall be endorsed as additional insured's by ISO form CG 20 26 - Additional Insured Designated Person or Organization. As additional insured's, they shall be covered as to work performed by or on behalf of the Contractor or as to liability which arises out of Contractor's activities or resulting from the performance of services or the delivery of goods called for by the Contract.

Contractor's insurance coverage shall be primary with respect to all additional insured's. Insurance or self-insurance

programs maintained by the designated additional insured's shall be in excess of the Contractor's insurance and shall not contribute with it.

Additionally, the Contractor and Contractor's automobile insurer shall agree to waive all rights of subrogation against the Owner and any of their respective officers, officials, agents, consultants or employees for claims, losses, or expenses which arise out of Contractor's activities or result from the performance of services or the delivery of goods called for by the Contract.

Contractor's failure to comply with the terms and conditions of these insurance policies shall not affect or abridge coverage for the Owner or for any of its officers, officials, agents, consultants or employees.

3. Workers' Compensation/Employer's Liability

Contractor's workers' compensation insurance shall be endorsed with NCCI form WC 00 03 01 A - Alternative Employer Endorsement. The Alternative Employer Endorsement shall designate the Owner as "alternate employers."

4. All Coverages

Each insurance policy required by this section of the Contract shall contain a stipulation, endorsed if necessary, that the Owner will receive a minimum of a thirty (30) calendar day advance notice of any policy cancellation. Ten (10) calendar days advance notice is required for policy cancellation due to non-payment of premium.

F. Insurer Qualifications and Acceptability

Insurance required hereunder shall be issued by an A.M. Best, "B+" rated, Class IX insurance company approved to conduct insurance business in the state of Missouri.

G. Verification of Insurance Coverage

Prior to Owner issuing a Notice to Proceed, the Contractor shall furnish the Owner with Certificate(s) of Insurance and with any applicable original endorsements evidencing the required insurance coverage. The insurance certificates and endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. All certificates and endorsements received by the Owner are subject to review and approval by the Owner. The Owner reserves the right to require certified copies of all required policies at any time. If the scope of this contract will exceed one (1) year - or, if any of Contractor's applicable insurance coverage expires prior to completion of the work or services required under this contract -

the Contractor will provide a renewal or replacement certificate before continuing work or services hereunder. If the Contractor fails to provide documentation of required insurance coverage, the Owner may issue a stop work order and no additional contract completion time and/or compensation shall be granted as a result thereof.

## **ARTICLE 7 – SUSPENSION OR TERMINATION OF CONTRACT**

### **ARTICLE 7.1 - FOR SITE CONDITIONS**

When conditions at the site of the proposed work are considered by the Owner to be unsatisfactory for prosecution of the work, the Contractor may be ordered in writing to suspend the work or any part thereof until reasonable conditions exist. When such suspension is not due to fault or negligence of the Contractor, time allowed for completion of such suspended work will be extended by a period of time equal to that lost due to delay occasioned by ordered suspension. This will be a no cost time extension.

### **ARTICLE 7.2 - FOR CAUSE**

#### **A. Termination or Suspension for Cause:**

1. If the Contractor shall file for bankruptcy, or should make a general assignment for the benefit of the creditors, or if a receiver should be appointed on account of insolvency, or if the contractor should persistently or repeatedly refuse or fail to supply enough properly skilled workers or proper materials, or if the contractor should fail to make prompt payment to subcontractors or for material or labor, or persistently disregard laws, ordinances or the instructions of the Owner, or otherwise be guilty of a substantial violation of any provision of this contract, then the Owner may serve notice on the Contractor and the surety setting forth the violations and demanding compliance with this contract. Unless within ten (10) consecutive calendar days after serving such notice, such violations shall cease and satisfactory arrangements for correction be made, the Owner may suspend the Contractor's right to proceed with the work or terminate this contract.
2. In the event the Owner suspends Contractor's right to proceed with the work or terminates the contract, the Owner may demand that the Contractor's surety take over and complete the work on this contract, after the surety submits a written proposal to the Owner and receives written approval and upon the surety's failure or refusal to do so within ten (10) consecutive

calendar days after demand therefore, the Owner may take over the work and prosecute the same to completion by bid or negotiated contract, or the Owner may elect to take possession of and utilize in completing the work such materials, supplies, appliances and plant as may be on the site of the work, and all subcontractors, if the Owner elects, shall be bound to perform their contracts.

- B. The Contractor and its surety shall be and remain liable to the Owner for any excess cost or damages occasioned to the Owner as a result of the actions above set forth.
- C. The Contractor in the event of such suspension or termination shall not be entitled to receive any further payments under this contract until the work is wholly finished. Then if the unpaid balance under this contract shall exceed all expenses of the Owner as certified by the Director, such excess shall be paid to the Contractor; but, if such expenses shall exceed the unpaid balance as certified by the Director, the Contractor and their surety shall be liable for and shall pay the difference and any damages to the Owner.
- D. In exercising Owner's right to secure completion of the work under any of the provisions hereof, the Director shall have the right to exercise Owner's sole discretion as to the manner, methods and reasonableness of costs of completing the work.
- E. The rights of the Owner to suspend or terminate as herein provided shall be cumulative and not exclusive and shall be in addition to any other remedy provided by law.
- F. The Contractor in the event of such suspension or termination may be declared ineligible for Owner contracts for a minimal period of twelve (12) months. Further, no contract will be awarded to any Contractor who lists in their bid form any subcontractor whose prior performance has contributed, as determined by the Owner, to a breach of a contract. In order to be considered for state-awarded contracts after this period, the Contractor/subcontractor will be required to forward acceptance reports to the Owner regarding successful completion of non-state projects during the intervening twelve (12) months from the date of default. No contracts will be awarded to a subcontractor/Contractor until the ability to perform responsibly in the private sector has been proven to the Owner.

### **ARTICLE 7.3 -- FOR CONVENIENCE**

- A. The Owner may terminate or suspend the Contract or any portion of the Work without cause at any time, and at the Owner's convenience. Notification of a termination or suspension shall be in writing

and shall be given to the Contractor and their surety. If the Contract is suspended, the notice will contain the anticipated duration of the suspension or the conditions under which work will be permitted to resume. If appropriate, the Contractor will be requested to demobilize and re-mobilize and will be reimbursed time and costs associated with the suspension.

B. Upon receipt of notification, the Contractor shall:

1. Cease operations when directed.
2. Take actions to protect the work and any stored materials.
3. Place no further subcontracts or orders for material, supplies, services or facilities except as may be necessary to complete the portion of the Contract that has not been terminated. No claim for payment of materials or supplies ordered after the termination date shall be considered.
4. Terminate all existing subcontracts, rentals, material, and equipment orders.

5. Settle all outstanding liabilities arising from termination with subcontractors and suppliers.

6. Transfer title and deliver to the Owner, work in progress, completed work, supplies and other material produced or acquire for the work terminated, and completed or partially completed plans, drawings information and other property that, if the Contract had been completed, would be required to be furnished to the Owner.

C. For termination without cause and at the Owner's convenience, in addition to payment for work completed prior to date of termination, the Contractor may be entitled to payment of other documented costs directly associated with the early termination of the contract. Payment for anticipated profit and unapplied overhead will not be allowed.

**SECTION 007300 - SUPPLEMENTARY CONDITIONS**

**1.0 GENERAL:**

A. These Supplementary General Conditions clarify, add, delete, or otherwise modify standard terms and conditions of DIVISION 0, BIDDING AND CONTRACTING REQUIREMENTS.

**2.0 CONTACTS:**

Designer: Andy Meyer  
Gastinger Walker  
817 Wyandotte St  
Kansas City, MO 64105  
Telephone: 816-569-0824  
Email: [ameyer@gastingerwalker.com](mailto:ameyer@gastingerwalker.com)

Laura Scott  
Gastinger Walker  
817 Wyandotte St  
Kansas City, MO 64105  
Telephone: 816-569-0834  
Email: [lscott@gastingerwalker.com](mailto:lscott@gastingerwalker.com)

Construction Representative: Ricky Howard  
Division of Facilities Management, Design and Construction  
836 N. Scott Ave.  
Belton, MO 64012  
Telephone: 816-728-0385  
Email: [ricky.howard@oa.mo.gov](mailto:ricky.howard@oa.mo.gov)

Project Manager: Christopher Lloyd  
Division of Facilities Management, Design and Construction  
301 West High Street, Room 730  
Jefferson City, Missouri 65101  
Telephone: 573-526-0160  
Email: Christopher. [Lloyd@oa.mo.gov](mailto:Lloyd@oa.mo.gov)

Contract Specialist: Mandy Roberson  
Division of Facilities Management, Design and Construction  
301 West High Street, Room 730  
Jefferson City, Missouri 65101  
Telephone: 573-522-0074  
Email: [mandy.roberson@oa.mo.gov](mailto:mandy.roberson@oa.mo.gov)

**3.0 NOTICE: ALL BID MATERIALS ARE DUE AT THE TIME OF BID SUBMITTAL. THERE IS NO SECOND SUBMITTAL FOR THIS PROJECT.**

**4.0 FURNISHING CONSTRUCTION DOCUMENTS:**

- A. The Owner will furnish the Contractor with approximately 10 complete sets of drawings and specifications at no charge.
- B. The Owner will furnish the Contractor with approximately 10 sets of explanatory or change drawings at no charge.
- C. The Contractor may make copies of the documents as needed with no additional cost to the Owner.

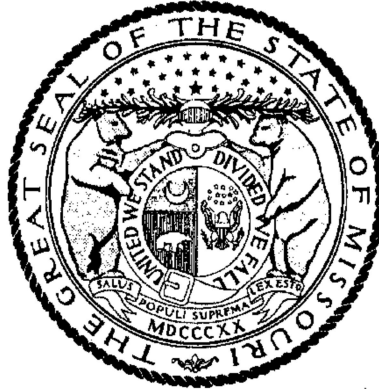
**5.0 SAFETY REQUIREMENTS**

Contractor and subcontractors at any tier shall comply with RSMo 292.675 and Article 1.3, E, of Section 007213, General Conditions.

# Missouri

## Division of Labor Standards

### WAGE AND HOUR SECTION



MICHAEL L. PARSON, Governor

# Annual Wage Order No. 30

Section 048  
**JACKSON COUNTY**

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by \_\_\_\_\_

Todd Smith, Director  
Division of Labor Standards

Filed With Secretary of State: \_\_\_\_\_ **March 10, 2023**

Last Date Objections May Be Filed: **April 10, 2023**

Prepared by Missouri Department of Labor and Industrial Relations



OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$68.67
Boilermaker	\$38.37*
Bricklayer	\$60.27
<b>Carpenter</b>	<b>\$61.82</b>
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$55.22
Plasterer	
Communications Technician	\$60.34
Electrician (Inside Wireman)	\$69.22
Electrician Outside Lineman	\$59.91
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$102.69
Glazier	\$58.17
Ironworker	\$68.53
Laborer	\$49.56
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$54.80
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$61.54
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$50.40
Plumber	\$76.04
Pipe Fitter	
Roofer	\$59.33
Sheet Metal Worker	\$72.78
Sprinkler Fitter	\$75.09
Truck Driver	\$52.39
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

\*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

\*\*The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMO Section 290.210.

Heavy Construction Rates for  
JACKSON County

Section 048

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$61.98
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$87.19
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$50.25
General Laborer	
Skilled Laborer	
Operating Engineer	\$58.85
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$50.18
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

\*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

\*\*The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.

# OVERTIME and HOLIDAYS

## OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, "**overtime work**" shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

## HOLIDAYS

January first;  
The last Monday in May;  
July fourth;  
The first Monday in September;  
November eleventh;  
The fourth Thursday in November; and  
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

## SECTION 011000 – SUMMARY OF WORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

#### 1.2 RELATED SECTIONS

- A. Section 012300 “Alternates”
- B. Section 125000 “Furniture”
- C. Appendix B1.01 “Radio Equipment Room – Scope of Work”

#### 1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Project consists of new construction of headquarters facility for Troop A of the Missouri State Highway Patrol.
  - 1. Project Location: 1900 NE Independence Ave, Lee’s Summit, MO 64086. (Also designated here as “Troop A HQ”
  - 2. Owner: State of Missouri, Office of Administration, Division of Facilities Management, Design and Construction, Harry S Truman State Office Building, Post Office Box 809, 301 West High Street, Jefferson City, Missouri 65102.
- B. Contract Documents, dated August 01, 2023 were prepared for the Project by GastingWalker& 817 Wyandotte, Kansas City, MO 64105.
  - 1. Contact: Jana Bee Triplett, (816) 421-8200, [jbeetriplett@gastingwalker.com](mailto:jbeetriplett@gastingwalker.com)
- C. Architect’s Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:
  - 1. Civil Engineering: Phelps Engineering, 1270 N. Winchester, Olathe, KS 66061
  - 2. Structural Engineering: Bob D Campbell & Company, 4338 Belleview Ave, Kansas City, MO 64111
  - 3. Mechanical, Plumbing, Electrical & Technology Engineering: IMEG, 1600 Baltimore, Suite 300, Kansas City, MO 64108
  - 4. Landscape Architecture: Meier Landscape Architecture, 155245 Metcalf Ave, Overland Park, KS 66223
- D. The Work consists of new headquarters for Missouri State Highway Patrol (MSHP) Troop A, including firing range building.
  - 1. The Work includes (2) buildings constructed of tilt-up concrete walls. Main building has steel structure and a TPO roof on steel decking and joists. Firing range building has steel structure and a TPO roof on a combination of steel decking and joists and precast concrete. The main building has a fire sprinkler system and a backup generator. Both buildings are served by ground-mount and rooftop HVAC units.

- E. The Work will be constructed under a single prime contract.

#### **1.4 CONTRACTOR USE OF PREMISES**

- A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises limited only by the Owner's right to perform work or to retain other contractors on portions of the Project.
- B. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
  - 1. Owner Occupancy: Allow for Owner occupancy and use by the public.
  - 2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

#### **1.5 OCCUPANCY REQUIREMENTS**

- A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate owner usage. Perform the Work so as not to interfere with the Owner's operations.
- B. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
  - 1. The Designer will prepare a Certificate of Partial Occupancy for each specific portion of the Work to be occupied prior to substantial completion.
  - 2. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the Owner will operate and maintain mechanical and electrical systems serving occupied portions for the building.
  - 3. Upon occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions for the building.

#### **1.6 MSHP-FURNISHED PRODUCTS/SERVICES**

- A. The MSHP will furnish the following items:
  - 1. Flags (3):
    - a. Owner furnished. Contractor installed.
  - 2. Vehicle Lifts:
    - a. Contractor to remove/salvage from existing Troop A building and install at new Troop A Headquarters.
  - 3. Tower:
    - a. Owner furnished. Contractor installed.
  - 4. Radio Equipment Room Servers:

- a. Reference Appendix B1.01 "Radio Equipment Room – Scope of Work"
  - 5. Door Card Readers:
    - a. Owner provided. Owner installed.
    - b. Contractor to provide wiring to locations per Electrical drawings.
  - 6. Security Cameras:
    - a. Owner provided. Owner installed.
    - b. Contractor to provide wiring to locations per Electrical drawings.
  - 7. Oil Fired Heater – Base Bid:
    - a. Reference Section 012300 "Alternates"
    - b. Contractor to remove/salvage from existing Troop A building and install at new Troop A Headquarters.
  - 8. Existing Furniture, Televisions, Printers, Projectors, Projection Screens, etc.
    - a. Reference Section 125000 "Furniture".
- B. The Work includes providing support systems to receive Owner's equipment, and mechanical and electrical connections.
- 1. The Owner will arrange for and deliver necessary shop drawings, product data, and samples to the Contractor.
  - 2. The Owner will arrange and pay for delivery of Owner-furnished items according to the contractor's Construction Schedule.
  - 3. The Contractor is responsible for receiving, unloading and handling Owner furnished items at the site.
  - 4. Following delivery, the Contractor will inspect items delivered for damage. The Contractor shall not accept damaged items and shall notify the Owner of rejection of damaged items.
  - 5. If Owner-furnished items are damaged, defective, or missing, the Owner will arrange for replacement.
  - 6. The Owner will arrange for manufacturer's field services and for the delivery of manufacturer's warranties to the appropriate Contractor.
  - 7. The Contractor shall designate delivery dates of Owner-furnished items in the Contractor's Construction Schedule.
  - 8. The Contractor shall review shop drawings, product data and samples and return them to the Designer noting discrepancies or problems anticipated in use of the project.
  - 9. The Contractor is responsible for protecting Owner-furnished items from damage, including damage from exposure to the elements. The Contractor shall repair or replace items damaged as a result of his operations.

## **PART 2 - PRODUCTS (Not Applicable)**

## **PART 3 - EXECUTION**

### **3.1 SCHEDULE OF PRODUCTS ORDERED IN ADVANCE (Not Applicable)**

### **3.2 MILESTONE SCHEDULE**

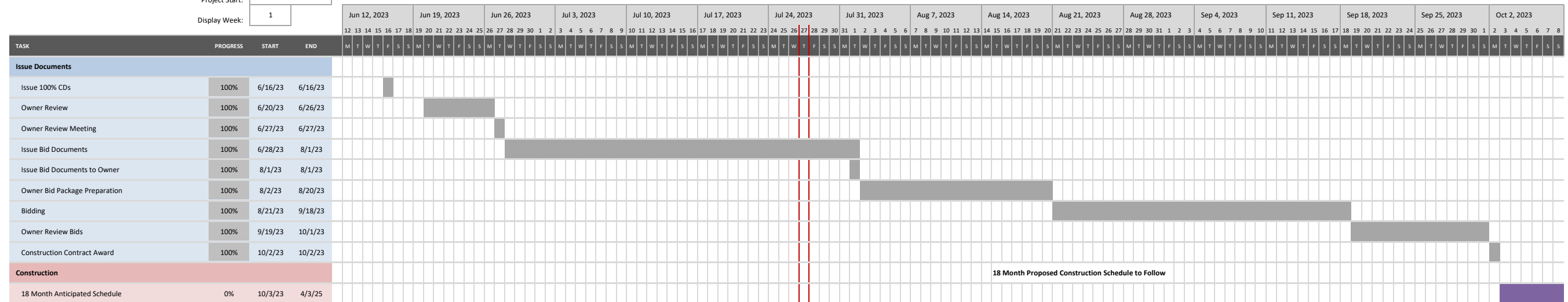
Troop A Headquarters, MSHP

Project Number: R2219-01

Proposed Milestone Schedule - August 2023 to April 2025

Project Start:

Display Week:



END OF SECTION 011000



## **SECTION 012100 – ALLOWANCES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements governing allowances.
  - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
  - 1. Weather allowances.
- C. Related Sections include the following:
  - 1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders for allowances.

#### **1.3 WEATHER ALLOWANCE**

- A. Included within the completion period for this project are a specified number of "bad weather" days (see Schedule of Allowances).
- B. The Contractor's progress schedule shall clearly indicate the bad weather day allowance as an "activity" or "activities". In the event weather conditions preclude performance of critical work activities for 50% or more of the Contractor's scheduled workday, that day shall be declared unavailable for work due to weather (a "bad weather" day) and charged against the above allowance. Critical work activities will be determined by review of the Contractor's current progress schedule.
- C. The Contractor's Representative and the Construction Representative shall agree monthly on the number of "bad weather" days to be charged against the allowance. This determination will be documented in writing and be signed by the Contractor and the Construction Representatives. If there is a failure to agree on all or part of the "bad weather" days for a particular month, that disagreement shall be noted on this written document and signed by each party's representative. Failure of the Contractor's representative to sign the "bad weather" day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the "bad weather" day determination contained in that document.
- D. There will be no modification to the time of contract performance due solely to the failure to deplete the "bad weather" day allowance.

- E. Once this allowance is depleted, a no cost Change Order time extension will be executed for “bad weather” days, as defined above, encountered during the remainder of the Project.

#### **1.4 SELECTION AND PURCHASE**

- A. At the earliest practical date after award of the Contract, Designer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Designer's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Designer from the designated supplier.

#### **1.5 SUBMITTALS**

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

#### **1.6 COORDINATION**

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION**

#### **1.7 EXAMINATION**

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

#### **1.8 PREPARATION**

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

#### **1.9 SCHEDULE OF ALLOWANCES**

- A. Weather Allowance: Included within the completion period for this Project: 45 “bad weather” days.

END OF SECTION 012100

**SECTION 012300 - ALTERNATES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Bid Form and other Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements governing Alternates.

**1.3 DEFINITIONS**

- A. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents..

1. The cost for each alternate is the net addition to the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.

- B. No additional time will be allowed for alternate work unless the number of work days is so stated on the bid form.

**1.4 PROCEDURES**

- A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate the Alternate Work into the Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

- B. Notification: The award of the Contract will indicate whether alternates have been accepted or rejected.

- C. Execute accepted alternates under the same conditions as other Work of this Contract.

- D. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections referenced in the Schedule contain requirements for materials necessary to achieve the Work described under each alternate.

**PART 2 - PRODUCTS (Not Applicable)****PART 3 - EXECUTION****3.1 SCHEDULE OF ALTERNATES**

- A. Alternate No. 1: New waste oil heater.

1. Base Bid: Remove/salvage and install existing waste oil heater. Provide new tank, associated controls and accessories.
  2. Alternate: Auto repair garage waste oil heater WOH-1, waste oil storage tank, associated controls, and accessories. Reference mechanical drawings for scheduled model and performance data.
  3. Added Construction Working Days: 0 days
- B. Alternate No. 2: Mobile storage in Files 131, Drug Evidence 175 and Evidence Storage 176.
1. Base Bid: Furnish and install (10) metal storage shelving units in Files 131, (33) metal storage shelving units in Drug Evidence 175, and (15) metal storage shelving units in Evidence Storage 176 as specified in Section 105613.
  2. Alternate: Furnish and install Mobile Storage Shelving in Files 131, Drug Evidence 175, and Evidence Storage 176 as specified in Section 105626.
  3. Added Construction Working Days: 0 days
- C. Alternate No. 3: Generator with 72-hour run time on full building.
1. Base Bid: Provide 275kW/244kVA diesel generator, MTS-4 and 800AMP distribution panel per Sheet E212.
  2. Alternate: Provide ATS-4, 1200AMP distribution panel and 800kW/1000kVA diesel generator with 72-hour fuel tank per Sheet E300.
  3. Added Construction Working Days: 0 days
- D. Alternate No. 4: Firing Range Building.
1. Base Bid: Construct main building with associated parking, sidewalks, utilities, landscaping, retaining walls, trash enclosure and impound lot.
  2. Alternate: Construct firing range building with associated parking, sidewalks and utilities.
  3. Added Construction Working Days: 0 days

END OF SECTION 012300

## **SECTION 012600 – CONTRACT MODIFICATION PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

#### **1.2 SUMMARY**

- A. This Section specifies administrative and procedural requirements for handling and processing Contract Modifications.
- B. Related Sections include the following:
  - 1. Division 1, Section 012100 "Allowances" for procedural requirements for handling and processing Allowances.
  - 2. Division 1, Section 013115 "Project Management Communications" for administrative requirements for communications.
  - 3. Division 0, Section 007213, Article 3.1 "Acceptable Substitutions" for administrative procedures for handling Requests for Substitutions made after Contract award.
  - 4. Division 0, Section 007213, Article 4.0 "Changes in the Work" for Change Order requirements.

#### **1.3 REQUESTS FOR INFORMATION**

- A. In the event that the Contractor or Subcontractor, at any tier, determines that some portion of the Drawings, Specifications, or other Contract Documents requires clarification or interpretation, the Contractor shall submit a "Request for Information" (RFI) in writing to the Designer. A RFI may only be submitted by the Contractor and shall only be submitted on the RFI forms provided by the Owner. The Contractor shall clearly and concisely set forth the issue for which clarification or interpretation is sought and why a response is needed. In the RFI, the Contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached.
- B. Responses to RFI shall be issued within ten (10) working days of receipt of the Request from the Contractor unless the Designer determines that a longer time is necessary to provide an adequate response. If a longer time is determined necessary by the Designer, the Designer will, within five (5) working days of receipt of the request, notify the Contractor of the anticipated response time. If the Contractor submits a RFI on a time sensitive activity on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Designer to respond to the request provided that the Designer responds within the ten (10) working days set forth above.
- C. Responses from the Designer will not change any requirement of the Contract Documents. In the event the Contractor believes that a response to a RFI will cause a change to the requirements of the Contract Document, the Contractor shall give written notice to the Designer requesting a Change Order for the work. Failure to give

such written notice within ten (10) working days, shall waive the Contractor's right to seek additional time or cost under Article 4, "Changes in the Work" of the General Conditions.

#### **1.4 MINOR CHANGES IN THE WORK**

- A. Designer will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Amount or the Contract Time, on "Designer's Supplemental Instructions" (DSI).

#### **1.5 PROPOSAL REQUESTS**

- A. The Designer or Owner Representative will issue a detailed description of proposed Changes in the Work that may require adjustment to the Contract Amount or the Contract Time. The proposed Change Description will be issued using the "Request for Proposal" (RFP) form. If necessary, the description will include supplemental or revised Drawings and Specifications.
1. Proposal Requests issued by the Designer or Owner Representative are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
  2. Within ten (10) working days after receipt of Proposal Request, submit a proposal for the cost adjustments to the Contract Amount and the Contract Time necessary to execute the Change. The Contractor shall submit his proposal on the appropriate Change Order Detailed Breakdown form. Subcontractors may use the appropriate Change Order Detailed Breakdown form or submit their proposal on their letterhead provided the same level of detail is included. All proposals shall include:
    - a. A detailed breakdown of costs per Article 4.1 of the General Conditions.
    - b. If requesting additional time per Article 4.2 of the General Conditions, include an updated Contractor's Construction Schedule that indicates the effect of the Change including, but not limited to, changes in activity duration, start and finish times, and activity relationship.

#### **1.6 CHANGE ORDER PROCEDURES**

- A. On Owner's approval of a Proposal Request, the Designer or Owner Representative will issue a Change Order for signatures of Owner and Contractor on the "Change Order" form.

#### **PART 2 - PRODUCTS (Not Used)**

#### **PART 3 - EXECUTION (Not Used)**

END OF SECTION 012600

## **SECTION 013100 – COORDINATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes administrative provisions for coordinating construction operations on Projects including, but not limited to, the following:
  - 1. Coordination Drawings.
  - 2. Administrative and supervisory personnel.
  - 3. Project meetings.
- B. Each Contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific Contractor.
- C. Related Sections include the following:
  - 1. Division 013200 section "Schedules-Bar Chart" for preparing and submitting Contractor's Construction Schedule.
  - 2. Articles 1.8.B and 1.8.C of Section 007213 "General Conditions" for coordinating meetings onsite.
  - 3. Article 5.4.H of Section 007213 "General Conditions" for coordinating Closeout of the Contract.

#### **1.3 COORDINATION**

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections, which depend on each other for proper installation, connection, and operation.
- B. Coordination: Each Contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.



4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components including mechanical and electrical.
- C. Prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate Contractors if coordination of their Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other Contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
  2. Preparation of the Schedule of Values.
  3. Installation and removal of temporary facilities and controls.
  4. Delivery and processing of submittals.
  5. Progress meetings.
  6. Preinstallation conferences.
  7. Startup and adjustment of systems.
  8. Project Closeout activities.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

#### 1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
- B. Key Personnel Names: Within fifteen (15) work days of starting construction operations, submit a list of key personnel assignments including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

## 1.5 PROJECT MEETINGS

- A. The Owner's Construction Representative will schedule a Pre-Construction Meeting prior to beginning of construction. The date, time, and exact place of this meeting will be determined after Contract Award and notification of all interested parties. The Contractor shall arrange to have the Job Superintendent and all prime Subcontractors present at the meeting. During the Pre-Construction Meeting, the construction procedures and information necessary for submitting payment requests will be discussed and materials distributed along with any other pertinent information.
1. Minutes: Designer will record and distribute meeting minutes.
- B. Progress Meetings: The Owner's Construction Representative will conduct Monthly Progress Meetings as stated in Articles 1.8.B and 1.8.C of Section 007213 "General Conditions".
1. Minutes: Designer will record and distribute to Contractor the meeting minutes.
- C. Preinstallation Conferences: Contractor shall conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of Manufacturers and Fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Designer and Construction Representative of scheduled meeting dates.
  2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration including requirements for the following:
    - a. Contract Documents
    - b. Options
    - c. Related RFIs
    - d. Related Change Orders
    - e. Purchases
    - f. Deliveries
    - g. Submittals
    - h. Review of mockups
    - i. Possible conflicts
    - j. Compatibility problems
    - k. Time schedules
    - l. Weather limitations
    - m. Manufacturer's written recommendations
    - n. Warranty requirements
    - o. Compatibility of materials

- p. Acceptability of substrates
  - q. Temporary facilities and controls
  - r. Space and access limitations
  - s. Regulations of authorities having jurisdiction
  - t. Testing and inspecting requirements
  - u. Installation procedures
  - v. Coordination with other Work
  - w. Required performance results
  - x. Protection of adjacent Work
  - y. Protection of construction and personnel
3. Contractor shall record significant conference discussions, agreements, and disagreements including required corrective measures and actions.
  4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
  5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
  6. Revise paragraph below if Project requires holding progress meetings at different intervals. Insert special intervals such as "every third Tuesday" to suit special circumstances.
  7. Project name
  8. Name and address of Contractor
  9. Name and address of Designer
  10. RFI number including RFIs that were dropped and not submitted
  11. RFI description
  12. Date the RFI was submitted
  13. Date Designer's response was received
  14. Identification of related DSI or Proposal Request, as appropriate

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

END OF SECTION 013100

## SECTION 013115 - PROJECT MANAGEMENT COMMUNICATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.
- B. Division 1, Section 013300 - Submittals
- C. Division 1, Section 012600 – Contract Modification Procedures

#### 1.2 SUMMARY

- A. Project Management Communications: The Contractor shall use the Internet web based project management communications tool, E-Builder® ASP software, and protocols included in that software during this project. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.
  - 1. Project management communications is available through E-Builder® as provided by "e-Builder®" in the form and manner required by the Owner.
  - 2. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited
- B. Support: E-Builder® will provide on-going support through on-line help files.
- C. Copyrights and Ownership: Nothing in this specification or the subsequent communications supersedes the parties' obligations and rights for copyright or document ownership as established by the Contract Documents. The use of CAD files, processes or design information distributed in this system is intended only for the project specified herein.
- D. Purpose: The intent of using E-Builder® is to improve project work efforts by promoting timely initial communications and responses. Secondly, to reduce the number of paper documents while providing improved record keeping by creation of electronic document files
- E. Authorized Users: Access to the web site will be by individuals who are authorized users.
  - 1. Individuals shall complete the E-Builder New Company/User Request Form located at the following web site: <https://oa.mo.gov/facilities/vendor-links/contractor-forms>. Completed forms shall be emailed to the following email address: [OA.FMDCE-BuilderSupport@oa.mo.gov](mailto:OA.FMDCE-BuilderSupport@oa.mo.gov).
  - 2. Authorized users will be contacted directly and assigned a temporary user password.
  - 3. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.
- F. Administrative Users: Administrative users have access and control of user licenses and all posted items. **DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!** Improper or abusive language toward any party or repeated posting of

items intended to deceive or disrupt the work of the project will not be tolerated and will result in deletion of the offensive items and revocation of user license at the sole discretion of the Administrative User(s).

- G. Communications: The use of fax, email and courier communication for this project is discouraged in favor of using E-Builder® to send messages. Communication functions are as follows:
1. Document Integrity and Revisions:
    - a. Documents, comments, drawings and other records posted to the system shall remain for the project record. The authorship time and date shall be recorded for each document submitted to the system. Submitting a new document or record with a unique ID, authorship, and time stamp shall be the method used to make modifications or corrections.
    - b. The system shall make it easy to identify revised or superseded documents and their predecessors.
    - c. Server or Client side software enhancements during the life of the project shall not alter or restrict the content of data published by the system. System upgrades shall not affect access to older documents or software.
  2. Document Security:
    - a. The system shall provide a method for communication of documents. Documents shall allow security group assignment to respect the contractual parties communication except for Administrative Users. **DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!**
  3. Document Integration:
    - a. Documents of various types shall be logically related to one another and discoverable. For example, requests for information, daily field reports, supplemental sketches and photographs shall be capable of reference as related records.
  4. Reporting:
    - a. The system shall be capable of generating reports for work in progress, and logs for each document type. Summary reports generated by the system shall be available for team members.
  5. Notifications and Distribution:
    - a. Document distribution to project members shall be accomplished both within the extranet system and via email as appropriate. Project document distribution to parties outside of the project communication system shall be accomplished by secure email of outgoing documents and attachments, readable by a standard email client.
  6. Required Document Types:
    - a. RFI, Request for Information.
    - b. Submittals, including record numbering by drawing and specification section.
    - c. Transmittals, including record of documents and materials delivered in hard copy.
    - d. Meeting Minutes.
    - e. Application for Payments (Draft or Pencil).
    - f. Review Comments.
    - g. Field Reports.
    - h. Construction Photographs.
    - i. Drawings.
    - j. Supplemental Sketches.
    - k. Schedules.
    - l. Specifications.
    - m. Request for Proposals

- n. Designer's Supplemental Instructions
  - o. Punch Lists
- H. Record Keeping: Except for paper documents, which require original signatures and large format documents (greater than 8½ x 11 inches), all other 8½ x 11 inches documents shall be submitted by transmission in electronic form to the E-Builder® web site by licensed users.
- a. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier shall respond to documents received in electronic form on the web site, and consider them as if received in paper document form.
  - b. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall reply or respond by transmissions in electronic form on the web site to documents actually received in paper document form.
  - c. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall copy any paper document into electronic form and make same available on the web site.
- I. Minimum Equipment and Internet Connection: In addition to other requirements specified in this Section, the Owner and his representatives, the Construction Manager and his representatives, the Architect and his consultants, and the Contractor and his sub-contractors and suppliers at every tier required to have a user license(s) shall be responsible for the following:
- 1. Providing suitable computer systems for each licensed user at the users normal work location<sup>1</sup> with high-speed Internet access, i.e. DSL, local cable company's Internet connection, or T1 connection.
  - 2. Each of the above referenced computer systems shall have the following minimum system<sup>2</sup> and software requirements:
    - a. Desktop configuration (Laptop configurations are similar and should be equal to or exceed desktop system.)
      - 1) Operating System: Windows XP or newer
      - 2) Internet Browser: Internet Explorer 6.01SP2+ (Recommend IE7.0+)
      - 3) Minimum Recommend Connection Speed: 256K or above
      - 4) Processor Speed: 1 Gigahertz and above
      - 5) RAM: 512 mb
      - 6) Operating system and software shall be properly licensed.
      - 7) Internet Explorer version 7 (current version is a free distribution for download). This specification is not intended to restrict the host server or client computers provided that industry standard HTTP clients may access the published content.
      - 8) Adobe Acrobat Reader (current version is a free distribution for download).
      - 9) Users should have the standard Microsoft Office Suite (current version must be purchased) or the equivalent.

## **PART 2 - PRODUCTS (Not Applicable)**

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**PART 3 - EXECUTION (Not Applicable.)**

END OF SECTION 013115

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<sup>1</sup> The normal work location is the place where the user is assigned for more than one-half of his time working on this project.

<sup>1</sup> The minimum system herein will not be sufficient for many tasks and may not be able to process all documents and files stored in the E-Builder® Documents area.

## **SECTION 013200 – SCHEDULE – BAR CHART**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes requirements for a Bar Chart Schedule for the project construction activities, schedule of submittals, and schedule for testing.

### **PART 2 - PRODUCTS – (Not Applicable)**

### **PART 3 - EXECUTION**

#### **3.1 SUBMITTAL PROCEDURES**

- A. The Contractor shall submit to the Designer, within ten (10) working days following the Notice to Proceed, a Progress Schedule including Schedule of Values showing the rate of progress the Contractor agrees to maintain and the order in which he proposed to carry out the various phases of Work. No payments shall be made to the Contractor until the Progress Schedule has been approved by the Owner.
  - 1. The Schedule of Values must have the following line items included with the value of the item as indicated below:
    - a. O&M's (Owner's Manual)
      - 1) \$1,000,000.00 (One million) and under – 2% of the total contract amount
      - 2) Over \$1,000,000.00 (One million) – 1% of the total contract amount
    - b. Close Out Documents
      - 1) \$1,000,000.00 (One million) and under – 2% of the total contract amount
      - 2) Over \$1,000,000.00 (One million) – 1% of the total contract amount
    - c. General Conditions
      - 1) No more than 10%
- B. The Contractor shall submit an updated Schedule for presentation at each Monthly Progress Meeting. The Schedule shall be updated by the Contractor as necessary to reflect the current Schedule and its relationship to the original Schedule. The updated Schedule shall reflect any changes in the logic, sequence, durations, or completion date. Payments to the Contractor shall be suspended if the Progress Schedule is not adequately updated to reflect actual conditions.



- C. The Contractor shall submit Progress Schedules to Subcontractors to permit coordinating their Progress Schedules to the general construction Work. The Contractor shall coordinate preparation and processing of Schedules and reports with performance of other construction activities.

### 3.2 CONSTRUCTION PROGRESS SCHEDULE – BAR CHART SCHEDULE

- A. Bar-Chart Schedule: The Contractor shall prepare a comprehensive, fully developed, horizontal bar chart-type Contractor's Construction Schedule. The Contractor for general construction shall prepare the Construction Schedule for the entire Project. The Schedule shall show the percentage of work to be completed at any time, anticipated monthly payments by Owner, as well as significant dates (such as completion of excavation, concrete foundation work, underground lines, superstructure, rough-ins, enclosure, hanging of fixtures, etc.) which shall serve as check points to determine compliance with the approved Schedule. The Schedule shall also include an activity for the number of "bad" weather days specified in Section 012100 – Allowances.
1. The Contractor shall provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.
    - a. If practical, use the same Schedule of Values breakdown for schedule time bars.
  2. The Contractor shall provide a base activity time bar showing duration for each construction activity. Each bar is to indicate start and completion dates for the activity. The Contractor is to place a contrasting bar below each original schedule activity time for indicating actual progress and planned remaining duration for the activity.
  3. The Contractor shall prepare the Schedule on a minimal number of separate sheets to readily show the data for the entire construction period.
  4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on schedule with other construction activities. Include minor elements involved in the overall sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.
  5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other required schedules and reports.
  6. Indicate the Intent to Award and the Contract Substantial Completion dates on the schedule.
- B. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
1. Requirement for Phased completion
  2. Work by separate Contractors
  3. Work by the Owner
  4. Pre-purchased materials
  5. Coordination with existing construction

6. Limitations of continued occupancies
  7. Un-interruptible services
  8. Partial Occupancy prior to Substantial Completion
  9. Site restrictions
  10. Provisions for future construction
  11. Seasonal variations
  12. Environmental control
- C. Work Stages: Use crosshatched bars to indicate important stages of construction for each major portion of the Work. Such stages include, but are not necessarily limited to, the following:
1. Subcontract awards
  2. Submittals
  3. Purchases
  4. Mockups
  5. Fabrication
  6. Sample testing
  7. Deliveries
  8. Installation
  9. Testing
  10. Adjusting
  11. Curing
  12. Startup and placement into final use and operation
- D. Area Separations: Provide a separate time bar to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.
1. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
    - a. Structural completion.
    - b. Permanent space enclosure
    - c. Completion of mechanical installation
    - d. Completion of the electrical portion of the Work
    - e. Substantial Completion

### 3.3 SCHEDULE OF SUBMITTALS

- A. Upon acceptance of the Construction Progress Schedule, prepare and submit a complete schedule of submittals. Coordinate the submittal schedule with Section

013300 SUBMITTALS, the approved Construction Progress Schedule, list of subcontracts, Schedule of Values and the list of products.

- B. Prepare the schedule in chronological order. Provide the following information
1. Scheduled date for the first submittal
  2. Related Section number
  3. Submittal category
  4. Name of the Subcontractor
  5. Description of the part of the Work covered
  6. Scheduled date for resubmittal
  7. Scheduled date for the Designer's final release or approval
- C. Distribution: Following the Designer's response to the initial submittal schedule, print and distribute copies to the Designer, Owner, subcontractors, and other parties required to comply with submittal dates indicated.
1. Post copies in the Project meeting room and temporary field office.
  2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.
- D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

### **3.4 SCHEDULE OF INSPECTIONS AND TESTS**

- A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule with (15) days of the date established for commencement of the Contract Work. The Contractor is to notify the testing agency at least (5) working days in advance of the required tests unless otherwise specified.
- B. Form: This schedule shall be in tabular form and shall include, but not be limited to, the following:
1. Specification Section number
  2. Description of the test
  3. Identification of applicable standards
  4. Identification of test methods
  5. Number of tests required
  6. Time schedule or time span for tests
  7. Entity responsible for performing tests
  8. Requirements for taking samples
  9. Unique characteristics of each service

- C. Distribution: Distribute the schedule to the Owner, Architect, and each party involved in performance of portions of the Work where inspections and tests are required.

END OF SECTION 013200

**SECTION 013300 – SUBMITTALS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.
- B. Division 1, Section 013115 “Project Management Communications” for administrative requirements for communications.

**1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for submittals required for performance of the Work including the following:
  - 1. Shop Drawings
  - 2. Product Data
  - 3. Product Datas
  - 4. Quality Assurance Submittals
  - 5. Construction Photographs
  - 6. Operating and Maintenance Manuals
  - 7. Warranties
- B. Administrative Submittals: Refer to General and Supplementary Conditions other applicable Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:
  - 1. Construction Progress Schedule including Schedule of Values
  - 2. Performance and Payment Bonds
  - 3. Insurance Certificates
  - 4. Applications for Payment
  - 5. Certified Payroll Reports
  - 6. Partial and Final Receipt of Payment and Release Forms
  - 7. Affidavit – Compliance with Prevailing Wage Law
  - 8. Record Drawings
  - 9. Notifications, Permits, etc.
- C. The Contractor is obliged and responsible to check all shop drawings and schedules to assure compliance with contract plans and specifications. The Contractor is responsible for the content of the shop drawings and coordination with other contract work. Shop drawings and schedules shall indicate, in detail, all parts of an Item or Work including erection and setting instructions and integration with the Work of other trades.

- D. The Contractor shall at all times make a copy, of all approved submittals, available on site to the Construction Representative.

### 1.3 SUBMITTAL PROCEDURES

- A. The Contractor shall comply with the General and Supplementary Conditions and other applicable sections of the Contract Documents. The Contractor shall submit, with such promptness as to cause no delay in his work or in that of any other contractors, all required submittals indicated in Part 3.1 of this section and elsewhere in the Contract Documents. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
    - a. The Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
- B. Each drawing and/or series of drawings submitted must be accompanied by a letter of transmittal giving a list of the titles and numbers of the drawings. Each series shall be numbered consecutively for ready reference and each drawing shall be marked with the following information:
  - 1. Date of Submission
  - 2. Name of Project
  - 3. Location
  - 4. Section Number of Specification
  - 5. State Project Number
  - 6. Name of Submitting Contractor
  - 7. Name of Subcontractor
  - 8. Indicate if Item is submitted as specified or as a substitution

### 1.4 SHOP DRAWINGS

- A. Comply with the General Conditions, Article 3.2.
- B. The Contractor shall submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- C. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings including the following information:

1. Dimensions
2. Identification of products and materials included by sheet and detail number
3. Compliance with specified standards
4. Notation of coordination requirements
5. Notation of dimensions established by field measurement
6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8½"x11" but no larger than 36"x48".

## 1.5 PRODUCT DATA

- A. The Contractor shall comply with the General Conditions, Article 3.2.
- B. The Contractor shall collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
  1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information including the following information:
    - a. Manufacturer's printed recommendations
    - b. Compliance with Trade Association standards
    - c. Compliance with recognized Testing Agency standards
    - d. Application of Testing Agency labels and seals
    - e. Notation of dimensions verified by field measurement
    - f. Notation of coordination requirements
  2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

## 1.6 PRODUCT DATAS

- A. The Contractor shall comply with the General Conditions, Article 3.2.
- B. The Contractor shall submit full-size, fully fabricated Product Datas, cured and finished as specified, and physically identical with the material or product proposed. Product Datas include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
  1. The Contractor shall mount or display Product Datas in the manner to facilitate review of qualities indicated. Prepare Product Datas to match the Designer's Product Data including the following:
    - a. Specification Section number and reference
    - b. Generic description of the Product Data
    - c. Product Data source

- d. Product name or name of the Manufacturer
  - e. Compliance with recognized standards
  - f. Availability and delivery time
2. The Contractor shall submit Product Datas for review of size, kind, color, pattern, and texture. Submit Product Datas for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three (3) multiple units that show approximate limits of the variations.
  - b. Refer to other Specification Sections for requirements for Product Datas that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
  - c. Refer to other Sections for Product Datas to be returned to the Contractor for incorporation in the Work. Such Product Datas must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Product Data submittals.
  - d. Product Datas not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
3. Field Product Datas are full-size examples erected onsite to illustrate finishes, coatings, or finish materials and to establish the Project standard.
- a. The Contractor shall comply with submittal requirements to the fullest extent possible. The Contractor shall process transmittal forms to provide a record of activity.

## 1.7 QUALITY ASSURANCE DOCUMENTS

- A. The Contractor shall comply with the General Conditions, Article 3.2
- B. The Contractor shall submit quality control submittals including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
- C. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the Manufacturer certifying compliance with specified requirements.
  - 1. Signature: Certification shall be signed by an officer of the Manufacturer or other individual authorized to contractually bind the Company.
- D. Inspection and Test Reports: The Contractor shall submit the required inspection and test reports from independent testing agencies as specified in this Section and in other Sections of the Contract Documents.



- E. Construction Photographs: The Contractor shall submit record construction photographs as specified in this Section and in other Sections of the Contract Documents.
1. The Contractor shall submit digital photographs. The Construction Administrator shall determine the quantity and naming convention at the preconstruction meeting.
  2. The Contractor shall identify each photograph with project name, location, number, date, time, and orientation.
  3. The Contractor shall submit progress photographs monthly unless specified otherwise. Photographs shall be taken one (1) week prior to submitting.
  4. The Contractor shall take four (4) site photographs from differing directions and a minimum of five (5) interior photographs indicating the relative progress of the Work.

## 1.8 OPERATING AND MAINTENANCE MANUALS AND WARRANTIES

- A. The Contractor shall submit all required manufacturer's operating instructions, maintenance/service manuals, and warranties in accordance with the General Conditions, Article 3.5, and Supplementary Conditions along with this and other Sections of the Contract Documents.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 REQUIRED SUBMITTALS

- A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

013200	Schedules	Construction Schedule
013200	Schedules	Schedule of Values
013200	Schedules	List of Subcontractors
013200	Schedules	Major Material Suppliers
033000	Cast-In-Place Concrete	
034713	Tilt-Up Concrete	
042000	Unit Masonry	
051200	Structural Steel Framing	
052100	Steel Joist Framing	
053100	Steel Decking	
054000	Cold Formed Metal Framing	
055000	Metal Fabrications	
064023	Interior Architectural Woodwork	
074233	Composite Wall Panels	
075423	Thermoplastic-Polyolefin (TPO) Roofing	
076200	Sheet Metal Flashing and Trim	
077123	Manufactured Gutters and Downspouts	
079200	Joint Sealants	

081113	Hollow Metal Doors and Frames
081416	Flush Wood Doors
083613	Sectional Doors
084113	Aluminum-Framed Entrances and Storefronts
084413	Glazed Aluminum Curtain Walls
085653	Security Windows
088000	Glazing
088300	Mirrors
092400	Cement Plastering
093000	Tiling
095113	Acoustical Ceilings
096513	Resilient Base and Accessories
096516	Resilient Sheet Flooring
096519	Resilient Tile Flooring
096813	Tile Carpeting
099123	Painting
101419	Dimensional Letter Signage
101423	Panel Signage
102113	Toilet Compartments
102213	Wire Mesh Partitions
102600	Wall and Door Protection
104416	Fire Protection Cabinets and Extinguishers
105613	Metal Storage Shelving
105113	Metal Evidence Lockers
105626	Mobile Storage Shelving Units
107516	Ground-Set Flagpoles
111200	Parking Control Equipment
116723	Shooting Range Equipment
122413	Roller Window Shades
125000	Furniture
210500	Owner Training Agenda
210503	Fire Seal Systems
210513	Motors
210529	Hangers and Supports
210548	Vibration Isolation Equipment
210553	Mechanical Identification
211300	Sprinkler Systems
211300	Fire Protection Equipment
212300	Fire Suppression Systems
220500	Owner Training Agenda
220513	Motors
220516	Expansion Compensation
220529	Hangers and Supports
220529	Prefabricated Curbs
220548	Vibration Isolation Equipment
220553	Plumbing Identification

- 220716 Plumbing Equipment Insulation
- 220719 Plumbing Pipe Insulation
- 220900 Instrumentation
- 221000 Plumbing Piping Systems and Valves
- 221023 Natural Gas and Propane Piping Systems
- 221030 Plumbing Specialties
- 221123 Domestic Water Pumps
- 223000 Plumbing Equipment
- 224000 Plumbing Fixtures
- 230500 Owner Training Agenda
- 230503 Fire Seal Systems
- 230513 Motors
- 230515 Variable Frequency Drives
- 230516 Expansion Compensation
- 230529 Hangers and Supports
- 230529 Prefabricated Curbs
- 230548 Vibration Isolation Equipment
- 230553 HVAC Identification
- 230593 TAB
- 230713 Duct Insulation
- 230716 HVAC Equipment Insulation
- 230719 HVAC Pipe Insulation
- 231123 Natural Gas Piping Systems
- 232100 Hydronic Piping Systems and Valves
- 232200 Condensate Piping Systems, Pumps and Valves
- 232300 Refrigeration Piping and Specialties
- 232500 Chemical Treatment Systems
- 233100 Duct Specialties (such as Turning Vanes)
- 233416 Centrifugal Fans
- 233423 Power Ventilators
- 233423 Prefabricated Curbs
- 233600 Terminal Air Boxes
- 233700 Grilles, Registers, Diffusers
- 234000 Filters and Filter Systems
- 235100 Prefabricated Stacks
- 235216 Condensing Boilers
- 236213 Air Cooled Condensing Units
- 260503 Through Penetration Firestopping
- 260513 Wire and Cables
- 260526 Grounding and Bonding
- 260533 Conduit and Boxes
- 260535 Surface Raceway
- 265530 Electrical Identification
- 260573 Power System Study
- 260933 Lighting Control System
- 262200 Dry Type Transformers

262300	Low-Voltage Switchgear
262413	Switchboards
262416	Panelboards
262726	Wiring Devices
262813	Fuses
262816	Disconnect Switches
263213	Packaged Engine Generator Systems
263600	Transfer Switches
264300	Surge Protection Devices
265119	LED Lighting
283100	Fire Alarm and Detection Systems
Drawings	Photocells, Timeclocks, Relays
270503	Through Penetration Firestopping
270526	Communications Bonding
270528	Interior Communications Pathways
270543	Exterior Communications Pathways
270553	Identification and Administration
271100	Communication Equipment Rooms
271300	Backbone Cabling Requirements
271500	Horizontal Cabling Requirements
271700	Testing

END OF SECTION 013300

**SECTION 013513.25 – SITE SECURITY AND HEALTH REQUIREMENTS (MSHP)****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

**1.2 SUBMITTALS**

- A. List of required submittals:
  - 1. Materials Safety Data Sheets for all hazardous materials to be brought onsite.
  - 2. Schedule of proposed shutdowns, if applicable.
  - 3. A list of the names of all employees who will submit fingerprints for a background check, and the signed privacy documents identified below for each employee.

**PART 2 - PRODUCTS (Not Applicable)****PART 3 - EXECUTION****3.1 ACCESS TO THE SITE**

- A. The Contractor shall arrange with Facility Representatives to establish procedures for the controlled entry of workers and materials into the work areas at the Facility.
- B. The Contractor shall establish regular working hours with Facility Representatives. The Contractor must report changes in working hours or overtime to Facility Representatives and obtain approval twenty-four (24) hours ahead of time. The Contractor shall report emergency overtime to Facility Representatives as soon as it is evident that overtime is needed. The Contractor must obtain approval from Facility Representatives for all work performed after dark.
- C. The Contractor shall provide the name and phone number of the Contractor's employee or agent who is in charge onsite; this individual must be able to be contacted in case of emergency. The Contractor must be able to furnish names and address of all employees upon request.
- D. All construction personnel shall visibly display issued identification cards.

**3.2 FIRE PROTECTION, SAFETY, AND HEALTH CONTROLS**

- A. The Contractor shall take all necessary precautions to guard against and eliminate possible fire hazards.
  - 1. Onsite burning is prohibited.
  - 2. The Contractor shall store all flammable or hazardous materials in proper containers located outside the buildings or offsite, if possible.
  - 3. The Contractor shall provide and maintain, in good order, during construction fire extinguishers as required by the National Fire Protection Association. In

areas of flammable liquids, asphalt, or electrical hazards, 15-pound carbon dioxide or 20-pound dry chemical extinguishers shall be provided.

- B. The Contractor shall not obstruct streets or walks without permission from the Owner's Construction Representative and Facility Representatives.
- C. The Contractor's personnel shall not exceed the speed limit of 15 mph while at the Facility unless otherwise posted.
- D. The Contractor shall take all necessary, reasonable measures to reduce air and water pollution by any material or equipment used during construction. The Contractor shall keep volatile wastes in covered containers, and shall not dispose of volatile wastes or oils in storm or sanitary drains.
- E. The Contractor shall keep the project site neat, orderly, and in a safe condition at all times. The Contractor shall immediately remove all hazardous waste, and shall not allow rubbish to accumulate. The Contractor shall provide onsite containers for collection of rubbish and shall dispose of it at frequent intervals during the progress of the Work.
- F. Fire exits, alarm systems, and sprinkler systems shall remain fully operational at all times, unless written approval is received from the Owner's Construction Representative and the appropriate Facility Representative at least twenty-four (24) hours in advance. The Contractor shall submit a written time schedule for any proposed shutdowns.
- G. For all hazardous materials brought onsite, Material Safety Data Sheets shall be on site and readily available upon request at least a day before delivery.
- H. Alcoholic beverages or illegal substances shall not be brought upon the Facility premises. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

### **3.3 MSHP SECURITY CLEARANCE REQUIREMENTS**

- A. Contractor Background Screening Policy: As a normal business activity, the Missouri State Highway Patrol (MSHP) may contract with external companies to perform various duties for the Missouri State Highway Patrol. Any personnel working for a contractor, and who has access to criminal justice information is required to pass a background check prior to beginning work on the contract. A contractor's proposed candidate may also be required to undergo a MSHP approved drug screening. This background check requirement will be included as part of all PAQs or solicitations for bids. The contract/PAQ award is contingent upon the proposed candidate background checks being completed.
- B. This background check will include, but not be limited to, state of residency and national fingerprint-based record checks. If the proposed candidate lives outside the United States, the contractor will submit similar documentation from their respective country. Qualification to work on contract will be based upon the following criteria:
  - 1. A felony conviction or guilty plea will be an automatic disapproval of the candidate.

2. Any conviction whether misdemeanor or felony, involving violence, crimes against children, and all sexual crimes regardless of timeframe will be an automatic disapproval of the candidate.
  3. Candidates will be disqualified if it is confirmed there are outstanding arrest warrants for the candidate.
  4. Any other misdemeanor convictions and guilty pleas may be considered for automatic disapproval. The State CSO (CJIS Security Officer) has final authority regarding if the nature or severity of the misdemeanor offense(s) does or does not warrant a disqualification.
- C. For misdemeanors, consideration will be given to the relationship between the information obtained in the background check and the responsibilities of the position. Time and severity of crime may also be considered as factors in a disqualification. Candidates may submit a written request for waiver through their contracting company if they have been disapproved and wish to contest the decision. The request will need to explain the circumstances of the crime and justification for a waiver.
- D. Contractors will be required to undergo a background check at a minimum once every five years. If there is a significant gap between contracts, candidates may be required to undergo a background check before working under a new contract.
- E. The CSO or their designee will maintain a list of contractors who have been approved to work at the MSHP.
- F. If a candidate goes through a background check with one contractor and then goes to work at a different contractor, the candidate will not be required to undergo a separate background check unless the timeframe exceeds five-year limit.
- G. The CSO for the MSHP has the right to approve or disapprove any candidate and has the right to revoke a candidate's approval at any time.
- H. The FBI CJIS Security Policy requires the MSHP to conduct background checks on all contractors needing MSHP access.
- I. Contractors working on-site and/or need escorted access are required to provide name, date of birth and social security number to enable the MSHP to run a name based background check prior to their arrival on-site.
- J. Contractors working on-site with unescorted access and/or need access to our network are required to submit fingerprints. Required fields for print cards are as follows:
1. ORI: MOMHP0070
  2. OCA: CONTRACTOR
  3. Employer and Address: COMPANY NAME AND ADDRESS
  4. Reason Fingerprinted: CONTRACTOR
- K. Contractors may submit fingerprints either at the MSHP General Headquarters, Annex Building, front office located at 1510 East Elm Street, Jefferson City, MO 65109, or may go to their local law enforcement agency to obtain a "copy" of their fingerprints (ten print or digital). There is a processing fee of \$33.25 per applicant. We accept check or money orders made payable to the "Criminal Record System Fund". Credit

card and debit cards only accepted at our location, no cash please. Fingerprints with processing fee can be mailed to the address below:

Missouri State Highway Patrol  
Criminal Justice Information Services Division  
Attn: Accounting, Annex Bldg.  
1510 East Elm Street  
Post Office Box 9500  
Jefferson City, MO 65102-9500

- L. Once background checks are completed, results will be returned via encrypted email to the requestor. Processing time varies. Please contact the Security Audit and Compliance Unit for questions at 573-526-6153 x2658.

### **3.4 DISRUPTION OF UTILITIES**

- A. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and the Facility Representative before disconnecting electric, gas, water, fire protection, or sewer service to any building.
- B. The Contractor shall give a minimum of seventy-two (72) hours written notice to the Construction Representative and Facility Representative before closing any access drives, and shall make temporary access available, if possible. The Contractor shall not obstruct streets, walks, or parking.

END OF SECTION 013513.25



**SECTION 015000 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

**1.2 SUMMARY**

- A. This Section includes requirements for construction facilities and temporary controls including temporary utilities, support facilities, security, and protection.
- B. Temporary utilities include, but are not limited to, the following:
  - 1. Water service and distribution
  - 2. Temporary electric power and light
  - 3. Temporary heat
  - 4. Ventilation
  - 5. Telephone service
  - 6. Sanitary facilities, including drinking water
  - 7. Storm and sanitary sewer
- C. Support facilities include, but are not limited to, the following:
  - 1. Field offices and storage sheds
  - 2. Temporary roads and paving
  - 3. Dewatering facilities and drains
  - 4. Temporary enclosures
  - 5. Temporary project identification signs and bulletin boards
  - 6. Waste disposal services
  - 7. Rodent and pest control
  - 8. Construction aids and miscellaneous services and facilities
- D. Security and protection facilities include, but are not limited to, to following:
  - 1. Temporary fire protection
  - 2. Barricades, warning signs, and lights
  - 3. Sidewalk bridge or enclosure fence for the site
  - 4. Environmental protection

**1.3 SUBMITTALS**

- A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

- B. Implementation and Termination Schedule: Within (15) days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

#### **1.4 QUALITY ASSURANCE**

- A. Regulations: Comply with industry standards and applicable laws and regulations including, but not limited to, the following:
  1. Building code requirements
  2. Health and safety regulations
  3. Utility company regulations
  4. Police, fire department, and rescue squad rules
  5. Environmental protection regulations
- B. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations". ANSI A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library "Temporary Electrical Facilities".
  1. Electrical Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70 "National Electric Code".
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

#### **1.5 PROJECT CONDITIONS**

- A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to the Owner, change over from use of temporary service to use of permanent service.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Relocate temporary services and facilities as the Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist onsite.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. General: Provide new materials. If acceptable to the Designer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.
- B. Lumber and Plywood: Comply with requirements in Division 6 Section "Rough Carpentry".

1. For job-built temporary office, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.
  2. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sized and thicknesses indicated.
  3. For fences and vision barriers, provide minimum 3/9" (9.5mm) thick exterior plywood.
  4. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" (16mm) thick exterior plywood.
- C. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.
- D. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary office, shops, and shed.
- E. Paint: Comply with requirements of Division 9 Section "Painting".
1. For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.
  2. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.
  3. For interior walls of temporary offices, provide two (2) quarts interior latex-flat wall paint.
- F. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.
- G. Water: Provide potable water approved by local health authorities.
- H. Open-Mesh Fencing: Provide 0.120" (3mm) thick, galvanized 2" (50mm) chainlink fabric fencing 6' (2m) high with galvanized steel pipe posts, 1½" (38mm) ID for line posts and 2½" (64mm) ID for corner posts.

## 2.2 EQUIPMENT

- A. General: Provide new equipment. If acceptable to the Designer, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.
- B. Water Hoses: Provide ¾" (19mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100' (30m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.
- C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110 to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

- D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage rating.
- E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixture where exposed to moisture.
- F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- G. Temporary Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.
- H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated re-circulation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers, or a combination of extinguishers of NFPA-recommended classes for the exposures.
  - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each Facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

### **3.2 TEMPORARY UTILITY INSTALLATION**

- A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with company recommendations.
  - 1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
  - 2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

3. Obtain easements to bring temporary utilities to the site where the Owner's easements cannot be used for that purpose.
  4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Designer. Neither the Owner nor Designer will accept cost or use charges as a basis of claims for Change Order.
- B. Temporary Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
1. Sterilization: Sterilize temporary water piping prior to use.
- C. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
1. Install electric power service underground, except where overhead service must be used.
  2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125V, AC 20ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
- D. Temporary Lighting: When overhead floor or roof deck has been installed, provide temporary lighting with local switching.
1. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.
- E. Temporary Heating: Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.
1. Heating Facilities: Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP gas or fuel-oil heaters with individual space thermostatic control.
  2. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.
- F. Temporary Telephones: Provide temporary telephone service throughout the construction period for all personnel engaged in construction activities.
1. Telephone Lines: Provide telephone lines for the following:
    - a. Where an office has more than two (2) occupants, install a telephone for each additional occupant or pair of occupants.
    - b. Provide a dedicated telephone for a fax machine in the field office.
    - c. Provide a separate line for the Owner's use.

2. At each telephone, post a list of important telephone numbers.
- G. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a health and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
1. Provide paper towels or similar disposable materials for each facility.
  2. Provide covered waste containers for used material.
- H. Drinking-Water Facilities: Provide containerized, tap-dispenser, bottled-water drinking-water units, including paper supply.
1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45°F to 55°F (7°C to 13°C).
- I. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

### 3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.
1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.
- B. Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at the Project site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip office as follows:
1. Furnish with a desk and chairs, a 4-drawer file cabinet, plan table, plan rack, and a 6-shelf bookcase.
  2. Equip with a water cooler and private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.
- C. Storage facilities: Install storage sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within the building or elsewhere onsite.
- D. Temporary Paving: Construct and maintain temporary roads and paving to support the indicated loading adequately and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas, and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with the Designer.
1. Paving: Comply with Division 2 Section "Hot-Mixed Asphalt Paving" for construction and maintenance of temporary paving.

2. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.
  3. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas without damage or deterioration when occupied by the Owner.
  4. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.
  5. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.
- E. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.
- F. Dewatering Facilities and Drains: For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.
- G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and materials drying or curing requirements to avoid dangerous conditions and effects.
  2. Install tarpaulins securely with incombustible wood framing and other materials. Close openings of 25SqFt (2.3SqM) or less with plywood or similar materials.
  3. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
  4. Where temporary wood or plywood enclosure exceeds 100SqFt (9.2SqM) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.
- H. Temporary Lifts and Hoists: Provide facilities for hoisting materials. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.
1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.

- 2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.
- J. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.
- K. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven (7) days during normal weather or three (3) days when the temperature is expected to rise above 80°F (27°C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.
- L. Rodent Pest Control: Before deep foundation work has been completed, retain a local exterminator or pest control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Employ this service to perform extermination and control procedures are regular intervals so the Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

### **3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION**

- A. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by the Designer.
- B. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of the types needed to protect against reasonable predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations".
  - 1. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one (1) extinguisher on each floor at or near each usable stairwell.
  - 2. Store combustible materials in containers in fire-safe locations.
  - 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.
  - 4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
- C. Permanent Fire Protection: At the earliest feasible date in each area of the Project complete installation of the permanent fire-protection facility including connected services and place into operation and use. Instruct key personnel on use of facilities.
- D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting including flashing red or amber lights.



- E. Enclosure Fence: Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.
  - 1. Provide open-mesh, chainlink fencing with posts set in a compacted mixture of gravel and earth.
- F. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
  - 1. Storage: Where materials and equipment must be stored and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- G. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and minimize the possibility that air, waterways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near the site.

### **3.5 OPERATION, TERMINATION AND REMOVAL**

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
  - 2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.
- C. Termination and Removal: Unless the Designer requests that it be maintained longer, remove each temporary facility when the need has ended, when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Materials and facilities that constitute temporary facilities are the Contractor's property. The Owner reserves the right to take possession of project identification signs.
  - 2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where the area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or

subsoil in the area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at the temporary entrances as required by the governing authority.

3. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
  - a. Replace air filters and clean inside of ductwork and housing.
  - b. Replace significantly worn parts and parts subject to unusual operating conditions.
  - c. Replace lamps burned out or noticeably dimmed by hours of use.

END OF SECTION 015000

## **SECTION 017400 - CLEANING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions Bid Form, and other Division 01 Specification Sections apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for cleaning during the Project.
- B. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with local laws and ordinances. Comply fully with federal and local environmental and anti-pollution regulations.
  - 1. Do not dispose of volatile wastes such as mineral spirits, oils, or paint thinner in storm or sanitary drains.
  - 2. Burning or burying of debris, rubbish, or other waste material on the premises is not permitted.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Cleaning Agents: Use cleaning materials and agents recommended by the manufacturer or fabricator for the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

### **PART 3 - EXECUTION**

#### **3.1 PROGRESS CLEANING**

- A. General
  - 1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage or traffic, and providing the required protection of materials.
  - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
  - 3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the jobsite.
  - 4. Provide adequate storage for all items awaiting removal from the jobsite, observing all requirements for fire protection and protection of the ecology.
- B. Site
  - 1. Daily, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
  - 2. Weekly, inspect all arrangements of materials stored onsite. Re-stack, tidy, or otherwise service all material arrangements.
  - 3. Maintain the site in a neat and orderly condition at all times.
- C. Structures
  - 1. Daily, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
  - 2. Weekly, sweep all interior spaces clean. "Clean" for the purposes of this paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and handheld broom.

3. In preparation for installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.
4. Following the installation of finish floor materials, clean the finish floor daily while work is being performed in the space in which finish materials have been installed. "Clean" for the purposes of this subparagraph, shall be interpreted as meaning free from all foreign material which, in the opinion of the Construction Representative, may be injurious to the finish of the finish floor material.

### **3.2 FINAL CLEANING**

- A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.
  1. Clean the Project Site, yard and grounds, in areas disturbed by construction activities including landscape development areas, of rubbish, waste material, litter, and foreign substances.
  2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
  3. Remove petrochemical spills, stains, and other foreign deposits.
  4. Remove tools, construction equipment, machinery, and surplus material from the site.
  5. Remove snow and ice to provide safe access to the building.
  6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  8. Broom clean concrete floors in unoccupied spaces.
  9. Vacuum clean carpet and similar soft surfaces removing debris and excess nap. Shampoo, if required.
  10. Clean transparent material, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
  11. Remove labels that are not permanent labels.
  12. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
  13. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  14. Clean plumbing fixtures to sanitary condition free of stains, including stains resulting from water exposure.
  15. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  16. Clean ducts, blowers, and coils if units were operated without filters during construction.
  17. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.

18. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters in fluorescent and mercury vapor fixtures.
  19. Leave the Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid the Project of rodents, insects, and other pests. Comply with regulations of local authorities.
  - D. Removal of Protection: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.
  - E. Compliances: Comply with governing regulations and safety standards for cleaning operations. Remove waste materials from the site and dispose of lawfully.
    1. Where extra materials of value remain after Final Acceptance by the Owner, they become the Owner's property.

END OF SECTION 017400

**SECTION 017900 - DEMONSTRATION AND TRAINING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
  - 3. Demonstration and training video recordings.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

**1.4 CLOSEOUT SUBMITTALS**

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
  - 1. Identification: On each copy, provide an applied label with the following information:
    - a. Name of Project.
    - b. Name and address of videographer.
    - c. Name of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Date of video recording.
  - 2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
  - 3. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

## 1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.
- C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Coordination". Review methods and procedures related to demonstration and training including, but not limited to, the following:
  - 1. Inspect and discuss locations and other facilities required for instruction.
  - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
  - 3. Review required content of instruction.
  - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

## 1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

## PART 2 - PRODUCTS

### 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.

- f. Operating characteristics.
  - g. Limiting conditions.
  - h. Performance curves.
2. Documentation: Review the following items in detail:
  - a. Emergency manuals.
  - b. Operations manuals.
  - c. Maintenance manuals.
  - d. Project record documents.
  - e. Identification systems.
  - f. Warranties and bonds.
  - g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
  - a. Instructions on meaning of warnings, trouble indications, and error messages.
  - b. Instructions on stopping.
  - c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:



- a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 007213 "General Conditions".
- B. Set up instructional equipment at instruction location.

#### **3.2 INSTRUCTION**

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Owner will furnish an instructor to describe Owner's operational philosophy.
  - 2. Owner will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner with at least seven days' advance notice.
- C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- D. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

#### **3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS**

- A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.
- B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.
1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
  2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
  3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
  4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
    - a. Name of Contractor/Installer.
    - b. Business address.
    - c. Business phone number.
    - d. Point of contact.
    - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
1. Film training session(s) in segments not to exceed 15 minutes.
    - a. Produce segments to present a single significant piece of equipment per segment.
    - b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    - c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.
- D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

END OF SECTION 017900

## **SECTION 02 22 00 - SITE DEMOLITION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes
  - 1. Demolition of structures, paving, and utilities.
  - 2. Filling voids created as a result of removals or demolition.
- B. Related Sections
  - 1. Section 02 23 00 - Site Clearing: Clearing of trees and other plant vegetation
  - 2. Section 31 10 00 – Earthwork: Placement of fill material

#### **1.2 REGULATORY REQUIREMENTS**

- A. Conform to applicable State and local codes for demolition of structures, safety of adjacent structures, dust control, and runoff control.
- B. Obtain required permits and licenses from appropriate authorities. Pay associated fees including disposal charges.
- C. Notify affected utility companies before starting work and comply with their requirements.
- D. Do not close or obstruct public or private roadways, sidewalks, or fire hydrants without appropriate permits or written authorization.
- E. Conform to applicable regulatory procedures when hazardous or contaminated materials are discovered.
- F. Test soils around buried tanks for contamination.

#### **1.3 SUBMITTALS**

- A. Project Record Documents: Accurately record actual locations of capped utilities and subsurface obstructions that will remain after demolition. Submit record as part of closeout submittals.

#### **1.4 PROJECT CONDITIONS**

- A. Structures to be demolished will be discontinued in use and vacated prior to start of work.
- B. Owner assumes no responsibility for condition of structures to be demolished.
- C. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as reasonably practical. Variations within structures may occur by Owner's removal and salvage operations prior to start of demolition work.
- D. Unless otherwise indicated in Contract Documents or specified by the Owner, items of salvageable value to Contractor shall be removed from site and structures. Storage or sale of removed items on site will not be permitted and shall not interfere with other work specified.
- E. Explosives shall not be brought to site or used without written consent of authorities having jurisdiction. Such written consent will not relieve Contractor of total responsibility for injury to persons or for damage to property due to blasting operations. Performance of required blasting shall comply with governing regulations.

**PART 2 - PRODUCTS**

## 2.1 FILL MATERIALS

- A. Fill material shall be aggregate fill materials as specified in other Sections.

**PART 3 - EXECUTION**

## 3.1 PREPARATION

- A. Provide, erect, and maintain erosion control devices, temporary barriers, and security devices at locations indicated on Construction Drawings.
- B. Protect existing landscaping materials, appurtenances, and structures, which are not to be demolished. Repair damage to existing items to remain caused by demolition operations.
- C. Prevent movement or settlement of adjacent structures. Provide bracing and shoring as necessary.
- D. Mark location of utilities. Protect and maintain in safe and operable condition utilities that are to remain. Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities as acceptable to governing authorities and Owner.
- E. Notify adjacent property owners of work that may affect their property, potential noise, utility outages, or other disruptions. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or limit access to their property. Coordinate notice with Owner.

## 3.2 GENERAL DEMOLITION REQUIREMENTS

- A. Conduct demolition to minimize interference with adjacent structures or pavements to remain.
- B. Cease operations immediately if adjacent structures appear to be in danger. Notify authority having jurisdiction. Do not resume operations until directed by authority.
- C. Conduct operations with minimum of interference to public or private access. Maintain ingress and egress at all times.
- D. Sprinkle work with water to minimize dust. Provide hoses and water connections for this purpose.
- E. Comply with governing regulations pertaining to environmental protection.
- F. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of work.
- G. Any damage caused by Contractor to off-site properties shall be immediately repaired by the Contractor at no additional costs to the Owner.
- H. When Contractor leaves the site unattended (such as end of day's work or on weekends), any open excavation or partially demolished structures shall be secured by placement of temporary orange fencing and signage indicating "Keep Out" or "Danger". Contractor may provide alternate means of securing site upon approval by the Owner.

## 3.3 DEMOLITION

- A. Demolish site improvements designated to be removed as shown on the drawings. Site improvements shall include but not be limited to structures, retaining walls, foundations, pavements, curbs and gutters, drainage structures, utilities, signage or landscaping.

- B. Disconnect and cap or remove utilities to be abandoned as shown on the drawings.
- C. Fill or remove underground tanks, piping, and appurtenances as shown.
- D. Demolish buildings completely and remove from site using methods as required to complete work within limitations of governing regulations. Small structures may be removed intact when acceptable to Owner and authorities having jurisdiction.
- E. Locate demolition equipment and remove materials to prevent excessive loading to supporting walls, floors, or framing.
- F. Demolish concrete and masonry in small sections. Break up concrete slabs-on-grade that are 2-feet or more below proposed subgrade to permit moisture drainage. Remove slabs-on-grade and below grade construction within 2-feet of proposed subgrade.

#### 3.4 FILLING BASEMENTS AND VOIDS

- A. Completely fill below grade areas and voids resulting from demolition or removal of structures, underground fuel storage tanks, wells, cisterns, etc., using aggregate fill materials consisting of stone, gravel, or sand free from debris, trash, frozen materials, roots, and other organic matter.
- B. Areas to be filled shall be free of standing water, frost, frozen or unsuitable material, trash, and debris prior to fill placement.
- C. Place fill materials in accordance with Section 31 10 00 unless subsequent excavation for new work is required.
- D. Grade surface to match adjacent grades and to provide flow of surface drainage after fill placement and compaction.

#### 3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove from site debris, rubbish, and other materials resulting from demolition operations. Leave areas of work in clean condition.
- B. No burning of any material, debris, or trash on-site or off-site will be allowed except when allowed by appropriate governing authority and Owner. If allowed as stated above, burning shall be performed in manner prescribed by governing authority. Attend burning materials until fires have burned out and have been completely extinguished.
- C. Transport materials removed from demolished structures with appropriate vehicles and dispose off-site to areas that are approved for disposal by governing authorities and appropriate property owners. Transported materials must be covered during transport.
- D. If disposal sites are on private property, the Contractor shall provide documentation to the Owner indicating that the site is approved for dumping or receiving waste materials and the type of materials that can be placed on the site.

**END OF SECTION 02 22 00**

## **SECTION 02 23 00 - SITE CLEARING**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes
  - 1. Cleaning site of debris, grass, trees, and other plant life in preparation for site or building earthwork.
  - 2. Protection of existing structures, trees, or vegetation indicated on the Construction Drawings to remain.
- B. Related Sections
  - 1. Section 02 22 00 – Site Demolition: Demolition and removal of structures, paving, utilities and other improvements.
  - 2. Section 31 10 00 – Earthwork: Stripping and removal of topsoil.

#### 1.2 ENVIRONMENTAL REQUIREMENTS

- A. Construct temporary erosion control systems as shown on Construction Drawings or as directed by the "Storm Water Pollution Prevention Plan" (SWPPP) to protect adjacent properties and water resources from erosion and sedimentation.
- B. In event that sitework on this project will disturb 1 or more acres; Contractor shall not begin construction without "National Pollution Discharge Elimination System" (NPDES) permit governing discharge of storm water from site for entire construction period. NPDES permit requires SWPPP to be in place during construction.
- C. Contractor shall conduct storm water management practices in accordance with NPDES permit and shall enforce action taken or imposed by Federal or State agencies, including cost of fines, construction delays, and remedial actions resulting from Contractor's failure to comply with provisions of NPDES permit.

#### 1.3 PROJECT CONDITIONS

- A. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as reasonably practical.

### **PART 2 - PRODUCTS**

Not Used

### **PART 3 - EXECUTION**

#### 3.1 PREPARATION

- A. Identify existing plant life that is to remain and verify clearing limits are clearly tagged, identified, and marked in such manner as to ensure their protection throughout construction operations.

#### 3.2 PROTECTION

- A. Locate, identify, and protect existing utilities that are to remain.
- B. Protect trees, plant growth, and features designated to remain as part of final landscaping.

- C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain ingress and egress at all times and clean or sweep roadways daily as required by SWPPP or governing authority. Dust control shall be provided with sprinkling systems or equipment provided by Contractor.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, in kind.
- E. Provide traffic control as required, in accordance with the US Department of Transportation's "Manual on Uniform Traffic Control Devices" and applicable state highway department requirements.

### 3.3 EQUIPMENT

- A. Material shall be transported to and from the project site using well-maintained and operating vehicles. Transporting vehicles operating on site shall stay on designated haul roads and shall not endanger improvements by rutting, overloading, or pumping.

### 3.4 CLEARING

- A. Clear areas required for access to site and execution of work.
- B. Unless otherwise indicated on Construction Drawings, remove trees, shrubs, grass, other vegetation, improvements, or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing and grubbing operations shall be filled to subgrade elevation to avoid ponding of water. Satisfactory fill material shall be placed in accordance with Section 02 23 00.
- C. Remove grass, trees, plant life, stumps, and other construction debris from site to dump site that is suitable for handling such material according to state laws and regulations.
- D. Cut heavy growths of grass from areas before stripping and topsoil removal and remove cuttings with remainder of cleared vegetative material.

**END OF SECTION 02 23 00**

## **SECTION 033000 CAST-IN-PLACE CONCRETE**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Floor slabs on grade.
- B. Concrete footings.
- C. Joint devices associated with concrete work.
- D. Miscellaneous concrete elements, including equipment pads.
- E. Concrete curing.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 07 92 00 - Joint Sealers.

#### **1.03 REFERENCE STANDARDS**

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.
- B. ACI 301 - Specifications for Structural Concrete; American Concrete Institute International.
- C. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International.
- D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.
- E. ACI 305R - Hot Weather Concreting; American Concrete Institute International.
- F. ACI 306R - Cold Weather Concreting; American Concrete Institute International.
- G. ACI 308R - Guide to Curing Concrete; American Concrete Institute International.
- H. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International.
- I. ASTM C 33 - Standard Specification for Concrete Aggregates.
- J. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- K. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete.
- L. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete.
- M. ASTM C 150 - Standard Specification for Portland Cement.
- N. ASTM C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- O. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.
  
- P. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- Q. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

#### **1.04 SUBMITTALS**

- A. See Section 01 33 00 - Submittals, for submittal procedures.



- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.

### **1.05 QUALITY ASSURANCE**

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. Follow recommendations of ACI 306R when concreting during cold weather.

## **PART 2 PRODUCTS**

### **2.01 CONCRETE MATERIALS**

- A. Cement: ASTM C 150, Type I - Normal portland type. B.  
Fine and Coarse Aggregates: ASTM C 33.
- C. Fly Ash: ASTM C 618, Class C.
- D. Water: Clean and not detrimental to concrete.

### **2.02 CHEMICAL ADMIXTURES**

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C 260. Provide one of the following:
  - 1. Air-Mix or Perma-Air, Euclid Chemical Co.
  - 2. Darex AEA or Daravair, W. R. Grace & Co.
  - 3. MB-VR or Micro-Air, Master Builders, Inc.
- C. Water-Reducing Admixture: ASTM C 494, Type A - Water Reducing.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Eucon WR-75, Euclid Chemical Co.
    - b. WRDA, W. R. Grace & Co.
    - c. Pozzolith Normal or Polyheed, Master Builders, Inc.
- D. High Range Water-Reducing Admixture: ASTM C 494, Type F - Water Reducing, High Range and Type G - Water Reducing, High Range and Retarding.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Eucon 37, Euclid Chemical Co.
    - b. WRDA 19 or Daracem, W. R. Grace & Co.
    - c. Rheobuild or Polyheed, Master Builders, Inc.
- E. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E - Water Reducing and Accelerating.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Accelguard 80, Euclid Chemical Co.
    - b. Daraset, W. R. Grace & Co.
    - c. Pozzutec 20, Master Builders, Inc.
- F. Water-Reducing, Retarding Admixture: ASTM C 494, Type D - Water Reducing and Retarding.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Eucon Retarder 75, Euclid Chemical Co.
    - b. Daratard-17, W. R. Grace & Co.
    - c. Pozzolith R, Master Builders, Inc.

2. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

### 2.03 ACCESSORY MATERIALS

- A. Vapor Retarder: Vapor Retarder membrane must have the following qualities
  1. Minimum Permeance ASTM E-96, Does not exceed 0.01 Perms
  2. Water Vapor Retarder ASTM E-1745 Meets or exceeds Class A
  3. Thickness of Retarder (plastic) ACI 302.1R Not less than 15 mils
  4. Seam Tape: High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4 inches.
  5. Pipe Boots: Construct pipe boots from vapor barrier material and pressure sensitive tape per manufacturer's instructions
    - a. Stego Wrap (15 mil) Vapor Barrier by Stego Industries, LLC
    - b. W.R. Meadows Vapor Mat 15.
- B. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type 1, Class B. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq. ft./gal.
  1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 mg per liter.
  2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Safe Cure Clear, ChemMasters Co. b. Kurez VOX, Euclid Chemical Co.
    - c. 1100-Clear, W. R Meadows
- C. Water-Based Acrylic Membrane Curing Compound (Exposed Slabs): ASTM C 309, Type 1, Class B.
  1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Dress & Seal WB, L & M Construction Chemicals, Inc. b. Aqua-Cure VOX, Euclid Chemical Co.
    - c. Kure-N-Seal W, Sonneborn. d. Vocomp-20, W. R. Meadows.
- D. Evaporation Control: Monomolecular film-forming ASTM C 309, Type 1, Class B.
  1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Safe Cure & Seal 0800, ChemMasters Co. b. Aqua-Cure Vox, Euclid Chemical Co.
    - c. Clearseal WB Gloss & Seal, Tamms/A.C. Horn
- E. Water Repellent: Clear, breathable, deep penetrating 100% saline sealer
  1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include:
    - a. Baracade Silane 100 Euclid Chemical Co
    - b. Sure Clean Wather Seal SL100 Water Repellant Prosoco
    - c. MasterProtect H 1000, BASF
- F. Non-Shrink Grout: ASTM C 1107/C 1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  1. Minimum Compressive Strength at 28 Days: 7,000 psi.

### 2.04 BONDING AND JOINTING PRODUCTS

- A. Joint Filler: Nonextruding, resilient asphalt impregnated fiberboard or felt, 1/2 inch thick and 4 inches deep; tongue and groove profile.
- B. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with ribbed steel stakes for setting.

1. Height: To suit slab thickness.
- C. Sealant and Primer: As specified in Section 07 92 00.

## **2.05 CONCRETE MIX DESIGN**

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.
- D. Normal Weight Concrete:
1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: As indicated on the Structural Drawings.
  2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
  3. Cement Content: As indicated on Structural Drawings
  4. Water-Cement Ratio: As indicated on Structural Drawings.
  5. Total Air Content: As indicated on Structural Drawings.
  6. Maximum Slump: As indicated on Structural Drawings.

## **2.06 MIXING**

- A. Transit Mixers: Comply with ASTM C 94/C 94M.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

### **3.02 PREPARATION**

- A. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

### **3.03 PLACING CONCRETE**

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Ensure reinforcement, inserts, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- D. Install Vapor Retarder: Installation shall be in accordance with manufacturer's instructions and ASTM E 1643.
1. Unroll vapor retarder with the longest dimension parallel with the direction of the pour.
  2. Lap vapor retarder over footings and seal to foundation walls.
  3. Overlap joints 6 inches and seal with manufacturer's tape.
  4. Seal all penetrations (including pipes) with pipe boot and tape.
  5. No penetration of the vapor retarder is allowed except for reinforcing steel and permanent utilities.
  6. Repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all four sides with tape
- E. Separate slabs on grade from vertical surfaces with joint filler.
- F. Place joint filler in floor slab pattern placement sequence. Set top to required elevations.

Secure to resist movement by wet concrete.

- G. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface. Conform to Section 07 90 05 for finish joint sealer requirements.
- H. Install joint devices in accordance with manufacturer's instructions.
- I. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- J. Place concrete continuously between predetermined expansion, control, and construction joints.
- K. Do not interrupt successive placement; do not permit cold joints to occur.
- L. Place floor slabs in checkerboard or saw cut pattern indicated.
- M. Saw cut joints for slabs on grade within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- N. Screed floors level, maintaining surface flatness in accordance with the requirements in the Contract Documents.

### 3.04 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Trowel Finish:
  - 1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
  - 2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
  - 3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 4. Do not add water to concrete surface.
  - 5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
  - 6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 7. Finish surfaces to the following tolerances, in accordance with [ASTM E1155](#) for a randomly trafficked floor surface:
    - a. Slabs on Ground:
      - 1) Specified overall values of flatness,  $F_F$  25; and of levelness,  $F_L$  20; with minimum local values of flatness,  $F_F$  17; and of levelness,  $F_L$  15.
      - 2) Specified overall values of flatness,  $F_F$  35; and of levelness,  $F_L$  25; with minimum local values of flatness,  $F_F$  24; and of levelness,  $F_L$  17.
      - 3) Specified overall values of flatness,  $F_F$  45; and of levelness,  $F_L$  35; with minimum local values of flatness,  $F_F$  30; and of levelness,  $F_L$  24.
- C. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
  - 1. Coordinate required final finish with Architect before application.
  - 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

- D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
  2. Coordinate required final finish with Architect before application.

### 3.05 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
1. Normal concrete: Not less than 7 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
  2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
  3. Final Curing: Begin after initial curing but before surface is dry.

### 3.06 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Compressive Strength Tests: ASTM C 39/C 39M. For each test, mold and cure four concrete test cylinders. Obtain test samples for every 50 cu yds. or less of concrete placed.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C 143/C 143M.

### 3.07 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

END OF SECTION 033000

## SECTION 034100 - PRECAST STRUCTURAL CONCRETE

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Precast structural concrete.

## 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.
- C. Shop Drawings:
  - 1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
  - 2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
  - 3. Indicate type, size, and length of welded connections by AWS standard symbols.
  - 4. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
  - 5. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
  - 6. Include and locate openings larger than 10 inches (250 mm). Where additional structural support is required, include header design.
  - 7. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
  - 8. Indicate relationship of precast structural concrete units to adjacent materials.
  - 9. Indicate shim sizes and grouting sequence.
  - 10. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
- D. Delegated Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Material Certificates: For the following:
  1. Cementitious materials.
  2. Reinforcing materials and prestressing tendons.
  3. Admixtures.
  4. Bearing pads.
  5. Insulation.
  6. Structural-steel shapes and hollow structural sections.
- C. Material Test Reports: For aggregates, by a qualified testing agency.
- D. Field quality-control and special inspection reports.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
- B. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.6 COORDINATION

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.
- B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.



1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
  2. Place adequate dunnage of even thickness between each unit.
  3. Place stored units so identification marks are clearly visible, and units can be inspected.
- C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.
- D. Lift and support units only at designated points indicated on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, to design precast structural concrete units
- B. Design Standards: Comply with **ACI 318 (ACI 318M)** and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.
- C. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets prescriptive requirements of authorities having jurisdiction or has been calculated according to [**ACI 216.1 (ACI 216.1M)**] [PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"] and is acceptable to authorities having jurisdiction.
- D. Structural Performance:
1. Precast structural concrete units and connections to withstand design loads indicated within limits and under conditions indicated.
  2. Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
    - a. Dead Loads: Per Drawings
    - b. Live Loads: Per Drawings
    - c. Seismic Loads: Per Drawings
    - d. Wind Loads: Per Drawings
    - e. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of **ACI 318 (ACI 318M)**.
      - 1) Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of 100 deg F
    - f. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

## 2.2 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
  - 1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

## 2.3 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.
- C. Steel Bar Mats: ASTM A184/A184M, fabricated from [ASTM A615/A615M, Grade 60 (Grade 420)] [ASTM A706/A706M], deformed bars, assembled with clips.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A185/A185M, fabricated from [as-drawn steel] [galvanized-steel] wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A497/A497M or ASTM A1064/A1064M, flat sheet.
- F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

## 2.4 PRESTRESSING TENDONS

- A. Pretensioning Strand: [ASTM A416/A416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, seven-wire or ASTM A886/A886M, Grade 270 (Grade 1860), indented, seven-wire, low-relaxation strand.

## 2.5 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type III, gray, unless otherwise indicated.
- B. Supplementary Cementitious Materials:
  - 1. Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3 percent.
  - 2. Metakaolin: ASTM C618, Class N.
  - 3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
  - 4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33/C33M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

- D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
- E. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
  - 1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. Water-Reducing and Accelerating Admixture: ASTM C494/C494M, Type E.
  - 5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  - 7. Plasticizing Admixture: ASTM C1017/C1017M, Type I.
  - 8. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

## 2.6 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A36/A36M.
- B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
- C. Carbon-Steel Plate: ASTM A283/A283M, Grade C.
- D. Malleable-Iron Castings: ASTM A47/A47M, Grade 32510 or Grade 35028.
- E. Carbon-Steel Castings: ASTM A27/A27M, **Grade 60-30** (**Grade 415-205**).
- F. High-Strength, Low-Alloy Structural Steel: ASTM A572/A572M.
- G. Carbon-Steel Structural Tubing: ASTM A500/A500M, Grade B or Grade C.
- H. Wrought Carbon-Steel Bars: ASTM A675/A675M, **Grade 65** (**Grade 450**).
- I. Deformed-Steel Wire or Bar Anchors: ASTM A496/A496M or ASTM A706/A706M.
- J. Carbon-Steel Bolts and Studs: **ASTM A307, Grade A** (**ASTM F568M, Property Class 4.6**); carbon-steel, hex-head bolts and studs; carbon-steel nuts, **ASTM A563** (**ASTM A563M**); and flat, unhardened steel washers, ASTM F844.
- K. High-Strength Bolts, Nuts, and Washers:
  - 1. ASTM F3125/F3125M, **Grade A325** (**Grade A325M**), Type 1, heavy-hex steel structural bolts; **ASTM A563, Grade DH**, (**ASTM A563M, Class 10S**) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

- a. Finish: Plain.
- L. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by [hot-dip process according to ASTM A123/A123M or ASTM A153/A153M.
  - 1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
  - 2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
- M. Welding Electrodes: Comply with AWS standards.
- N. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

## 2.7 BEARING PADS

- A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:
  - 1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D2240; minimum tensile strength 2250 psi (15.5 MPa), ASTM D412.
  - 2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
  - 3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
  - 4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
  - 5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

## 2.8 ACCESSORIES

- A. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install structural precast concrete units.

## 2.9 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by

volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

- B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881/C881M, of type, grade, and class to suit requirements.

## 2.10 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
  1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
  2. Limit use of fly ash to 20 percent replacement of portland cement by weight and ground granulated blast-furnace slag to 20 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by [ACI 318 \(ACI 318M\)](#) or PCI MNL 116 when tested according to ASTM C1218/C1218M.
- D. Water Absorption: For structural precast concrete with an architectural finish, limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C642, except for boiling requirement.
- E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
- F. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
- G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

## 2.11 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release

agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

- B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
  1. Edge and Corner Treatment: Uniformly chamfered

## 2.12 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
  1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
- D. Cast-in openings larger than **10 inches (250 mm)** in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
  1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
  2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
  3. Place reinforcing steel and prestressing strand to maintain at least **3/4-inch (19-mm)** minimum concrete cover. Increase cover requirements for reinforcing steel to **1-1/2 inches (38 mm)** when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

- G. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- H. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
- I. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.
  - 1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.
- J. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.
- K. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.
- L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- M. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

## 2.13 FABRICATION TOLERANCES

- A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

## 2.14 COMMERCIAL FINISHES

- A. Grade B Finish: Fill air pockets and holes larger than **1/4 inch (6 mm)** in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than **1/8 inch (3 mm)** in width that occur more than once per **2 sq. in. (1300 sq. mm)**. Grind smooth form offsets or fins larger than **1/8 inch (3 mm)**. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.
- B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

## 2.15 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.
1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- B. Strength of precast structural concrete units is considered deficient if units fail to comply with **ACI 318 (ACI 318M)** requirements for concrete strength.
- C. If there is evidence that strength of precast concrete units may be deficient or may not comply with **ACI 318 (ACI 318M)** requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42/C42M.
1. A minimum of three representative cores to be taken from units of suspect strength, from locations directed by Architect.
  2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
  3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
  4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:
    - a. Project identification name and number.
    - b. Date when tests were performed.
    - c. Name of precast concrete fabricator.
    - d. Name of concrete testing agency.
    - e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- D. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- E. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

### 3.2 INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
- B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.
  - 1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
  - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - 3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
- C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
  - 1. Do not permit connections to disrupt continuity of roof flashing.
- D. Field cutting of precast units is not permitted without approval of Architect.
- E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.
- F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
  - 1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.

2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780/A780M.
  3. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.
- G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
  2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:
    - a. Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
    - b. Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
    - c. Twist-off Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
    - d. Direct-Tension Control Bolt: ASTM F3125/F3125M, Grade 1852.
  3. For slip-critical connections, use method and inspection procedure approved by Architect and coordinated with inspection agency.
- H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.
1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
  2. Fill joints completely without seepage to other surfaces.
  3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
  4. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
  5. Keep grouted joints damp for not less than 24 hours after initial set.

### 3.3 ERECTION TOLERANCES

- A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
- B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

### 3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Erection of precast structural concrete members.

- B. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections are subject to inspections.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

### 3.5 REPAIRS

- A. Repair precast structural concrete units if permitted by Architect.
  - 1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of **20 feet (6 m)**.
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

### 3.6 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
  - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

## **SECTION 034713 - TILT-UP CONCRETE**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes load-bearing, tilt-up concrete, including the following:
  - 1. Monolithic panels.
  - 2. Insulated-sandwich panels.
- B. Related Requirements:
  - 1. Section 076200 "Sheet Metal Flashing and Trim" for flashing receivers and reglets.

#### **1.2 DEFINITIONS**

- A. Face-down Surface: Concealed surface of as-cast, tilt-up panel formed against the casting slab.
- B. Face-up Surface: Exposed upper surface of as-cast, tilt-up panel.
- C. Reveal: Projection of the coarse aggregate from the matrix after exposure.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Before submitting design mixes, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with tilt-up concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Tilt-up concrete Subcontractor.
  - 2. Review special inspection procedures; testing and inspecting agency procedures for field quality control; tilt-up concrete finishes and finishing; cold- and hot-weather concreting procedures; curing procedures; casting-slab construction, flatness and levelness, finish, and joint requirements; steel reinforcement installation; hoisting and erection plans; measurement of fabrication and erection tolerances; tilt-up concrete repair procedures; and tilt-up concrete protection.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Shop Drawings: Detail fabrication and installation of tilt-up concrete units. Indicate panel locations, plans, elevations, dimensions, shapes, cross sections, and details of steel embedments.
  - 1. Include steel reinforcement, detailing fabrication, bending, and placing. Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and supports of concrete reinforcement.
  - 2. Include additional steel reinforcement to resist hoisting and erection stresses.
  - 3. Include locations and details of hoisting points and lifting devices for handling and erection.
  - 4. Include engineering analysis data of additional steel reinforcement and hoisting and erection details, signed and sealed by the qualified professional engineer responsible for their preparation.
  - 5. Indicate welded connections by AWS standard symbols. Detail cast-in inserts, connections, and joints, including accessories.
  - 6. Include layout of wythe connectors for sandwich panels.
- D. Samples: **[5-lb (2.3-kg)]** Sample of exposed aggregate.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Steel reinforcement and accessories.
  - 4. Bond breakers.
  - 5. Curing compounds.
  - 6. Inserts and embedments.
- C. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- D. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

- B. Installer Qualifications: A qualified installer who employs a supervisor on Project who is an ACI-certified Tilt-up Supervisor.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M.
  - 2. AWS D1.4/D1.4M.
- D. Mockups: Cast and erect tilt-up concrete panel mockups to demonstrate typical reveals, surface finishes, texture, color, and standard of workmanship.
  - 1. Build mockup panels in the location and of the size indicated or, if not indicated, as directed by Architect.
  - 2. In presence of Architect, damage part of an exposed surface for each finish, color, and texture required, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete mixtures.

## PART 2 - PRODUCTS

### 2.1 TILT-UP CONCRETE

- A. Comply with **ACI 301 (ACI 301M)**, unless modified by requirements in the Contract Documents.

### 2.2 FORMS AND ACCESSORIES

- A. Forms: Metal, dressed lumber, or other approved materials that are nonreactive with concrete and that will provide continuous, true, and smooth concrete surfaces.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, **3/4 by 3/4 inch (19 by 19 mm)**.
- C. Reveal Strips: Metal, PVC, rubber, straight dressed wood, or plywood; with sides kerfed.
- D. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleedwater and prevent migration of set-retarding chemicals from wood or plywood.

### 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 (Grade 420)**, deformed.
- B. Plain-Steel Wire: ASTM A82/A82M

- C. Plain-Steel Welded-Wire Reinforcement: ASTM A185/A185M, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded-Wire Reinforcement: ASTM A497/A497M, flat sheet.
- E. Bar Supports: Manufactured according to CRSI's "Manual of Standard Practice" of plastic or CRSI Class 1 plastic-protected steel wire or Class 2 stainless steel wire.

## 2.4 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Material:
  1. Portland Cement: ASTM C150/C150M, Type I/II
  2. Fly Ash: ASTM C618, Class C.
  3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- C. Coarse Aggregate: ASTM C33/C33M, graded. Provide aggregates from single source
  1. Maximum Coarse-Aggregate Size: 1 inch (25 mm)
- D. Fine Aggregate: ASTM C33/C33M, manufactured or natural sand, from same source for Project, free of materials with deleterious reactivity to alkali in cement.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  2. Retarding Admixture: ASTM C494/C494M, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- G. Water: ASTM C94/C94M and potable.

## 2.5 BOND BREAKERS

- A. Solvent-Borne, Chemically Reactive Bond Breaker: Penetrating polymerized solution containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

- B. Waterborne, Membrane-Forming Bond Breaker: Dissipating polymerized emulsion containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

## 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B.

## 2.7 CONNECTION MATERIALS

- A. Embedded Metal Items and Loose Hardware: Comply with Section 055000 "Metal Fabrications" for materials for securing tilt-up concrete panels together and to supporting and adjacent construction.
- B. Loose Hardware: Comply with Section 055000 "Metal Fabrications" for materials for securing tilt-up concrete panels together and to supporting and adjacent construction.
- C. Carbon-Steel Shapes and Plates: ASTM A36/A36M.
- D. Carbon-Steel Bolts and Studs: ASTM A307, Grade A (ASTM F568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- E. Unheaded Carbon-Steel Rods and Nuts: ASTM A36/A36M, threaded rods with ASTM A563, nuts.
- F. Welded Headed Studs: AWS D1.1/D1.1M, Type B headed studs, and cold-finished, carbon-steel bars.
- G. Chord Bar Sleeves: Tubular sheathing, plastic or moisture-resistance-treated cardboard.
- H. Welding Electrodes: Comply with AWS standards.
- I. Hot-Dip Galvanized Finish: Apply zinc coating to steel connections by hot-dip process, complying with ASTM A123/A123M or ASTM A153/A153M as applicable.
  - 1. Zinc Repair Paint: SSPC-Paint 20.



## 2.8 LIFTING INSERTS AND ACCESSORIES

- A. Furnish inserts, dowels, bolts, nuts, washers, and other items to be cast in panels for tilting and lifting.
  - 1. Manufacture inserts with feet of plastic, galvanized-steel wire, plastic-tipped steel wire, or stainless steel-tipped steel wire.
- B. Furnish brace anchors and other accessories to be cast in panels and in casting slab for attaching bracing.
  - 1. Manufacture wall brace anchors and accessories with feet of galvanized-steel wire, plastic-tipped steel wire, or stainless steel-tipped steel wire.
  - 2. Manufacture floor brace anchors that do not penetrate vapor retarder under slab-on-grade.

## 2.9 BEARING PADS

- A. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet; Type A Shore durometer hardness of 50 to 70, ASTM D2240; and minimum tensile strength of 2250 psi (15.5 MPa), ASTM D412.
- B. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer with a Type A Shore durometer hardness of 70 to 90, ASTM D2240.
- C. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded in elastomer with a Type A Shore durometer hardness of 80 to 100, ASTM D2240.
- D. High-Density Plastic Strips: Multimonomer, nonleaching plastic.

## 2.10 GROUT

- A. Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

## 2.11 MISCELLANEOUS MATERIALS

- A. Form Retarder: Chemical liquid set retarder, for application on hardened horizontal concrete and capable of temporarily delaying final hardening of newly placed concrete to depth of reveal specified.
  - 1. Mold Release: Solution specially formulated by manufacturer for use under form retarder.

## 2.12 REPAIR MATERIALS

- A. Bonding Agent: ASTM C1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- B. Patching Mortar: Dry-pack mix consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing **No. 16 (1.18-mm)** sieve, using only enough water for handling and placing.

## 2.13 CONCRETE MIXTURES

- A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.
- B. Prepare design mixtures for each type and strength of concrete, proportioned on basis of laboratory trial mixture or field test data, or both, according to **ACI 301 (ACI 301M)**.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures based on laboratory trial mixtures.
- C. Proportion concrete mixture as follows:
  - 1. Minimum Compressive Strength: **5000 psi (34.5 MPa)**
  - 2. Maximum W/C Ratio: 0.45.
  - 3. Slump Limit: **4 inches (100 mm)** before adding high-range, water-reducing admixture or plasticizing admixture plus or minus **1 inch (25 mm)**.
  - 4. Air Content: 6 percent plus or minus 1.5 percent for **1-inch (25-mm)** nominal maximum aggregate size at point of delivery.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing high-range, water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

## 2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
  - 1. When air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.

## **PART 3 - EXECUTION**

### **3.1 FORMWORK INSTALLATION**

- A. Construct and brace formwork so tilt-up concrete panels are of size, shape, alignment, elevation, and position indicated.
  - 1. Construct forms on slab-on-grade or on temporary casting slab, at Contractor's option.
  - 2. Provide for openings, offsets, recesses, reveals, rustications, reglets, and blockouts.
- B. Construct forms for easy removal without hammering or prying against concrete surfaces. Use kerfed inserts, such as those forming reglets, rustications, and recesses, for easy removal.
- C. Set edge forms for panels to achieve required panel thickness.
- D. Chamfer exposed corners and edges, unless otherwise indicated, using chamfer strips fabricated to produce uniform, smooth lines and tight edge joints.
- E. Coat contact surfaces of wood forms and chamfers with sealer before placing reinforcement.

### **3.2 BOND BREAKER INSTALLATION**

- A. Uniformly and continuously apply two coats of bond breaker to casting-slab surfaces by power spray or roller according to manufacturer's written instructions, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.
- B. After placing steel reinforcement, touch up or recoat worn or damaged areas with bond breaker. Do not splash or coat steel reinforcement and inserts.

### **3.3 FORM RETARDER APPLICATION**

- A. Uniformly and continuously apply form retarder to slab surfaces by power spray, roller, or brush according to manufacturer's written instructions, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.
  - 1. Uniformly apply mold release according to manufacturer's written instructions and allow it to dry before applying form retarder.
- B. After placing steel reinforcement, touch up or recoat worn or damaged areas with form retarder. Do not splash or coat steel reinforcement and inserts.

### 3.4 REINFORCEMENT AND INSERT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating and placing reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 1. Field weld reinforcement according to AWS D1.4/D1.4M, where indicated.
  - 2. Do not tack-weld crossing reinforcing bars.
  - 3. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- C. Accurately place and securely support embedded items, anchorages, inserts, cramps, retainers, bar chords and sleeves, and other items to be built into panels. Coordinate with other trades for installing cast-in items.

### 3.5 PANEL CASTING, GENERAL

- A. Comply with ACI 301 (ACI 301M) for handling, placing, and consolidating concrete.
- B. Maintain position of steel reinforcement, inserts, and anchors during concrete placement, consolidation, and finishing.
- C. Screed panel surfaces to correct level with a straightedge and strike off.
  - 1. Begin initial floating before excess moisture or bleedwater appears on the surface. Use bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows. Do not disturb panel surfaces before beginning finishing operations.
- D. Form chamfers at top edges of panel perimeters, openings, and similar locations not formed by chamfer strips unless otherwise indicated.
- E. Surface Defects: Limit visible surface defects to those permitted by TCA's "Tilt-up Concrete Association's Guideline Specifications" for Grade B, Standard panel surfaces.

### 3.6 CASTING TOLERANCES

- A. Cast tilt-up concrete panels without exceeding the following tolerances:
  - 1. Height and Width of Panels:
    - a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm) wide.
    - b. For Panels 20 to 30 Feet (6.1 to 9.1 m) Tall: 3/8 inch (10 mm) wide.
    - c. Each Additional 10 Feet (3.05 m) in Excess of 30 Feet (9.1 m) Tall: 1/8 inch (3 mm) wide.
  - 2. Thickness: 3/16 inch (5 mm).
  - 3. Skew of Panel or Opening: Difference in length of diagonals of 1/8 inch per 72 inches (3 mm per 1830 mm) with a maximum difference of 1/2 inch (13 mm).

4. Openings Cast into Panel:
  - a. Size of Opening: **1/4 inch (6 mm)**.
  - b. Location of Centerline of Opening: **1/4 inch (6 mm)**.
5. Location and Placement of Embedded Items:
  - a. Inserts, Bolts, and Pipe Sleeves: **3/8 inch (10 mm)**.
  - b. Lifting and Bracing Inserts: As required by manufacturer.
  - c. Lateral Placement of Weld Plate Embedments: **1 inch (25 mm)**.
  - d. Tipping and Flushness of Weld Plate Embedments: **1/4 inch (6 mm)**.
6. Deviation of Steel Reinforcement Cover: Maintain minimum cover required by **ACI 301 (ACI 301M)**.

### 3.7 FACE-DOWN FINISHES

- A. Smooth, As-Cast Finish: Cast panel to produce a surface free of pockets, sand streaks, and honeycombs. Produce a surface appearance of uniform color and texture.

### 3.8 CONCRETE PROTECTING AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures according to **ACI 301 (ACI 301M)**.
  1. Apply evaporation retarder in hot, dry, or windy weather to protect concrete from rapid moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after screeding and bull floating concrete, but before float finishing.
- B. Begin curing immediately after finishing concrete. Cure by one or a combination of the following methods according to ACI 308.1:
  1. Moisture Curing: Keep surfaces continuously moist for no fewer than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with **12-inch (300-mm)** lap over adjacent absorptive covers.
  2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches (300 mm)**, and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
  3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.9 ERECTION

- A. Use erection equipment with care to prevent damage to floor slabs and panels.
- B. Lift, support, and erect panels only at designated lifting or supporting points indicated on Shop Drawings.
- C. Do not erect panels until 75 percent of 28-day compressive strength of concrete has been verified.
- D. Install tilt-up concrete panels level, plumb, square, and true. Place panels on leveled grout-setting pads or shims in correct position. Maintain joint width of **3/4 inch (19 mm)**
- E. Temporarily brace and support panels securely in position against loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to panels are secured.
- F. Anchor panels in place and, if indicated, to one another.
  - 1. Weld steel connectors to steel supports and embedments indicated, complying with AWS D1.1/D1.1M.
- G. Solidly grout-fill gaps between foundation system and bottom of panels.

### 3.10 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform tests and inspections and prepare test reports.
- B. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Steel reinforcement welding.
  - 3. Headed bolts and studs.
  - 4. Verification of use of required design mixture.
  - 5. Concrete placement, including conveying and depositing.
  - 6. Curing procedures and maintenance of curing temperature.
  - 7. Verification of concrete strength before erection of tilt-up panels.
- C. Testing Services: Tests to be performed according to **ACI 301 (ACI 301M)**.
- D. Tilt-up concrete panels will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.11 ERECTION TOLERANCES

- A. Install tilt-up concrete panels without exceeding the following erection tolerances:

1. Joint Width Variation (Exterior Face): Without decreasing or increasing more than 50 percent from specified joint width, maintain joint width as follows:
  - a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm).
  - b. Each Additional 10 Feet (3.05 m) in Excess of 20 Feet (6.1 m) Tall: 1/8 inch (3 mm).
2. Joint Taper: Maximum 3/8 inch (10 mm) over length, but not greater than the following:
  - a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm).
  - b. Each Additional 10 Feet (3.05 m) in Excess of 20 Feet (6.1 m) Tall: 1/8 inch (3 mm).
3. Panel Alignment:
  - a. Alignment of Horizontal and Vertical Joints: 1/4 inch (6 mm).
  - b. Offset in Exterior Face of Adjacent Panels: 1/4 inch (6 mm).

### 3.12 FILLING AND REPAIR

- A. Patch holes and voids left by erecting and bracing inserts on tilt-up panels and slabs-on-grade. Cut or chip edges of voids perpendicular to concrete surface. Fill blockouts where indicated.
  1. Clean, dampen with water, and brush-coat holes, voids, and blockouts with bonding agent. Fill and compact with patching mortar of a stiff consistency before bonding agent has dried.
  2. Finish surfaces of fills and repairs to Architect's approval, with materials of same colors and textures as finishes on surrounding surfaces.
- B. Repair damaged galvanized-steel surfaces of connectors by cleaning and applying a coat of zinc repair paint.
- C. Repair damage to tilt-up panels and slabs-on-grade resulting from tilt-up work, as directed by Architect.
- D. Remove and replace tilt-up panels that do not comply with requirements in this Section.
- E. Demolish and remove temporary concrete casting slabs.

END OF SECTION 034713

## SECTION 042000- UNIT MASONRY

## PART 1 - GENERAL

## 1.01 SECTION INCLUDES

1. Concrete masonry units (CMU's).

## 1.02 RELATED SECTIONS

2. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
3. Section 076200 "Sheet Metal Flashing and Trim" for furnishing manufactured reglets installed in masonry joints.

## 1.2 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties and material test reports substantiating compliance with requirements.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.



1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

## 1.5 QUALITY ASSURANCE

- A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

## 1.6 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  2. Protect sills, ledges, and projections from mortar droppings.
  3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

## PART 2 - PRODUCTS

### 2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

## 2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding and other special conditions.
  - 2. Provide bullnose units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
  - 2. Density Classification: Lightweight unless otherwise indicated.

## 2.3 CONCRETE AND MASONRY LINTELS

- A. General: Provide concrete and masonry lintels as indicated on Drawings, comply with requirements below
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
  - 1. inches (194 mm) long].

## 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Capital Materials Corporation; Flamingo Color Masonry Cement.
    - b. Holcim (US) Inc.; [Mortamix Masonry Cement] .
    - c. Lafarge North America Inc.; [Magnolia Masonry Cement] [Lafarge Masonry Cement].
    - d. Lehigh Cement Company; [Lehigh Masonry Cement] .
    - e. National Cement Company, Inc.; Coosa Masonry Cement.
- E. AGGREGATE FOR MORTAR: ASTM C 144.
  - 1. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

F. AGGREGATE FOR GROUT: ASTM C 404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Euclid Chemical Company (The); Accelguard 80.
  - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
  - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.

## 2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Wire Size for Side Rods: [0.187-inch (4.76-mm)] diameter.
3. Wire Size for Cross Rods: [0.187-inch (4.76-mm)] diameter.
4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
5. Provide in lengths of not less than 10 feet (3 m)[, with prefabricated corner and tee units].

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

## 2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.

1. Wire: Fabricate from 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.

- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  - 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.
  - 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from [0.25-inch- (6.35-mm-)] diameter, hot-dip galvanized steel wire.
- D. Partition Top anchors: 0.105-inch- (2.66-mm-) thick metal plate with 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.
  - 1. Corrosion Protection: [Hot-dip galvanized to comply with ASTM A 153/A 153M].

## 2.7 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane or PVC.
- B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

## 2.8 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
    - a. Diedrich Technologies, Inc.
    - b. EaCo Chem, Inc.
    - c. ProSoCo, Inc.

## 2.9 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
  2. Use [portland cement-lime] [or] [masonry cement] mortar unless otherwise indicated.
  3. For exterior masonry, use [portland cement-lime] [or] [masonry cement] mortar.
  4. For reinforced masonry, use [portland cement-lime] [or] [masonry cement] mortar.
  5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, [Proportion] Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use [Type S].
  2. For reinforced masonry, use Type N.
  3. For mortar parge coats, use Type S or Type N.
  4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
  5. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
  2. Proportion grout in accordance with ASTM C 476, specified 28-day compressive strength of 2500 psi.
  3. Provide grout with a slump of 5 to 9 inches as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

### 3.2 TOLERANCES

- A. Dimensions and Locations of Elements:
1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

### 3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

### 3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMUs as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.5 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
  - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
  - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings[ in addition to continuous reinforcement].
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.6 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
  - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install preformed control-joint gaskets designed to fit standard sash block.
  3. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick as follows:
1. Build flanges of factory-fabricated, expansion-joint units into masonry.
  2. Build in compressible joint fillers where indicated.
  3. Form open joint full depth of brick wythe and of width indicated, but not less than **3/8 inch** for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

### 3.7 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.8 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  2. Limit height of vertical grout pours to not more than 60 inches.



### 3.9 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 1 special inspections according to the "International Building Code."
  - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
  - 3. Place grout only after inspectors have verified proportions of site-prepared grout.

### 3.10 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Protect surfaces from contact with cleaner.
  - 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

### 3.11 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

## **SECTION 051200 STRUCTURAL STEEL FRAMING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Structural steel framing members, support members.
- B. Base plates and shear stud connectors.
- C. Grouting under base plates.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 21 00 - Steel Joist Framing.
- B. Section 05 31 00 - Steel Decking: Support framing for small openings in deck.
- C. Section 05 50 00 - Metal Fabrications: Steel fabrications affecting structural steel work.

#### **1.03 REFERENCE STANDARDS**

- A. AISC (MAN) - Steel Construction Manual; American Institute of Steel Construction, Inc.
- B. AISC - Code of Standard Practice for Steel Buildings and Bridges; American Institute of Steel Construction, Inc.
- C. AISC - Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- D. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A 108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
- F. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- G. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric).
- H. ASTM A 500/A 500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- I. ASTM A 992/A 992M - Standard Specification for Structural Steel Shapes.
- J. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.
- L. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

#### **1.04 SUBMITTALS**

- A. See Section 01 30 00 - Submittals, for submittal procedures.
- B. Shop Drawings:

1. Materials shall not be fabricated or delivered to the site before the approved shop drawings have been returned to the Contractor. Only shop drawings completely checked by the Fabricator and Contractor will be considered.
  2. Manufacturing or fabricating of any material prior to the approval of shop drawings will be at the risk of the Contractor.
  3. Approval of shop drawings is for conformance with the Contract Documents only.  
Contractor is responsible for dimensions, quantities, and coordination with other trades. Drawings shall include all shop and erection details, including cuts, copes, connections, holes, bolts and welds in structural steel.
  4. All welds, both shop and field, shall be indicated by standard welding symbols in the American Welding Society Standard Code of Arc and Gas Welding in Building Construction.
  5. Drawings shall show the size, length and type of each weld.
  6. Approval of shop drawings does not authorize changes to contract requirements unless stated in a separate letter or a change order. Where design details are changed in the preparation of shop drawings in an attempt to improve construction, such changes are to be noted on the shop drawings.
- C. Substitutions of Sections: Substitutions of sections or modifications of details, or both, and reasons therefore shall be submitted with shop drawings for approval. Approved substitutions, modifications, and necessary changes in related portions of work shall be coordinated by Contractor and shall be accomplished at no additional cost to Owner.
- D. Responsibility for Errors: Contractor shall be responsible for all errors of detailing, fabrication, and for correct fitting of structural members. Make all measurements in field as required to verify or supplement dimensions shown on Drawings and assume all responsibility for fitting all work.
- E. Templates: Templates shall be furnished by the Fabricator to the job, together with instructions for the setting of anchors, anchor bolts, and bearing plates. The Contractor shall ascertain that the items are properly set during the progress of the work.
- F. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.

### **1.05 QUALITY ASSURANCE**

- A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."
- B. Fabricator: The structural steel shall be fabricated in a plant certified by the AISC as Category STD (Steel Building Structures). Otherwise the structural steel fabricator must demonstrate, to the satisfaction of the Architect and Engineer, a consistent record of a least ten (10) successful projects of equal or greater magnitude over the preceeding two (2) years. The Contractor shall submit evidence in writing verifying one of the above required qualifications within 48 hours of end of bid/negotiation or subject fabricator to disqualification.
- C. Erector: Company specializing in performing the work of this section with minimum 5 years of documented experience.
- D. Design connections not detailed on the drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the state of Kansas for the forces provided on the structural drawings.

### **1.06 REGULATORY REQUIREMENTS**

- A. Conform to UL Assembly Design No. indicated on the Drawings or as required by local code.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Steel Angles and Plates: ASTM A 36/A 36M.
- B. Steel W Shapes and Tees: ASTM A 992/A 992M.
- C. Rolled Steel Structural Shapes: ASTM A 992/A 992M. D.  
Cold-Formed Structural Tubing: ASTM A 500, Grade B.
- E. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
- F. High-Strength Structural Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, medium carbon, plain.
- G. Welding Materials: AWS D1.1; type required for materials being welded.
- H. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C 1107/C 1107M and capable of developing a minimum compressive strength of 6000 psi at 28 days.
- I. Shop and Touch-Up Primer: SSPC-Paint 15, Type 1 - Red or Gray Oxide; 2 mils thick minimum.

### **2.02 FABRICATION**

- A. Shop fabricate to greatest extent possible.
- B. Workmanship: Comply with provisions of Part 1 of AISC "Specification of the Design, Fabrication and Erection of Structural Steel for Buildings".
- C. Assembly: Structural material shall be fabricated and assembled in shop to greatest extent possible. Shearing, flame cutting, and shipping shall be done carefully and accurately. Parts not completely connected in shop shall be secured by bolts, insofar as is practicable, to prevent damage in shipment and handling.
- D. Connections:
  1. Shop connections shall, in general, be welded. Field connections shall be bolted with A-325 bolts or welded at contractors' option unless specifically indicated on the construction documents. Connections shall be made to conform to the AISC. One-sided or other types of eccentric connections will not be permitted unless shown on the Drawings.
  2. ASTM A 325 bolts shall be used for all bolted connections except where unfinished bolts are shown on the Drawings.
  3. Welded connections shall conform to the AISC.
  4. Bolted Connections using ASTM A 325 high strength bolts shall conform to the Specification for "Structural Joints Using ASTM A 325 or A 490 Bolts", as approved by Research Council on Riveted and Bolted Structural Joints and endorsed by the American Institute of Steel Construction. Bolt threads shall be excluded from the shear planes of the contact surfaces between the connected parts.
- F. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- G. Fabricate connections for bolt, nut, and washer connectors.
- H. Develop required camber for members as indicated on the Drawings.

### **2.03 FINISH**

- A. Shop prime structural steel members with standard gray primer. Do not prime surfaces that will be on top flange of beams to receive shear studs, fireproofed, field

welded, in contact with concrete, or high strength bolted.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

#### **3.02 ERECTION**

- A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".
- B. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
- E. Do not field cut or alter structural members without approval of Architect.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
- G. Alignment:
  - 1. After assembly, the various members forming parts of a completed frame or structure shall be aligned and adjusted accurately before tightening bolts. Tolerance shall conform to AISC. Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the work shall be securely fastened to take care of all dead load, wind and erection stresses. Splices will be permitted only where indicated.
  - 2. Unless removal is required, all erection bolts used in welded construction may be tightened securely and left in place. Where erection bolts are removed, the holes shall be filled with plug welds and ground smooth. Welding for redrilling will not be permitted.
- H. Bolting:
  - 1. There shall first be enough bolts brought to a "snug tight" condition to insure that the parts of the joint are brought into good contact with each other. Snug tight is defined as the tightness that exist when all plies in a joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the connection shall then be tightened additionally one half turn of the nut, with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.
  - 2. Bolts in slip critical connections, connections subject to direct tension, and fully pre-tensioned bearing connections shall be installed in properly aligned holes

and tightened by one of the methods described in Subsections 8.2.1 through 8.2.4 of the "Specification For Structural Joints Using ASTM A325 or A490 Bolts" to at least the minimum tension specified in Table 8.1 when all fasteners are tight.

- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- J. Driftpins: May be used only to bring together the several parts, and shall not be used in such a manner as to distort or damage the metal.
- K. Cutting: The use of a gas cutting torch in the field for correcting fabrication errors shall not be done on any major member in the structural framing. The use of a gas cutting torch is permissible only on minor member, when the member is not under stress, and only when the approval of the Architect has been specifically given.
- L. Bracing: The frame of steel skeleton buildings shall be carried up true and plumb, within limits defined in the Code of Standard Practice, latest edition, of the American Institute of Steel Construction. Temporary bracing shall be provided, in accordance with the requirements of the Code of Standard Practice, wherever necessary to take care of all loads to which the structure may be subjected, including equipment and the operation of same. Such bracing shall be left in place as long as may be required for safety.
- M. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

### 3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

### 3.04 FIELD QUALITY CONTROL

- A. General:
  - 1. Owner shall employ an Independent Testing Laboratory (ITL) to inspect high-strength bolted connections, welded connections, perform tests, and prepare test reports.
  - 2. ITL shall conduct/interpret tests and state in each report whether test specimens comply with requirements and specifically state any deviations therefrom.
  - 3. The Contractor shall correct deficiencies in structural steel work which inspections/laboratory test reports have indicated are not in compliance with requirements.  
Additional tests as necessary shall be performed by the ITL to reconfirm any non-compliance of original work. Such tests and/or additional services of the Architect made necessary by such non-compliance shall be paid for by the Contractor.
- B. Structural Steel Testing:
  - 1. ITL will secure samples of structural steel, not identified by mill test reports, heat or melt numbers, in ample quantities to perform structural tests on 5% by weight of all unidentified steel which will consist of tensile, bend, and elongation tests per ASTM A 370.
- C. Field Welding:
  - 1. The ITL will inspect/test during erection of structural steel assemblies in accordance with the following: AWS D1.1.

- a. Certify welders and conduct inspection/tests as required. Record types/location of all defects found in work. Record work required and performed to correct deficiencies.
  - b. Perform visual inspection of all welds for size, pinholes, undercut, and overlap. Any visual indication of cracks shall be checked further using magnetic particle testing methods.
  - c. Perform non-destructive tests of welds as follows:
    - 1) Fillet welds - one (1) spot per member. Magnetic particle testing may be used.
    - 2) Partial penetration welds - one (1) spot test per weld using magnetic particle testing techniques.
    - 3) Full penetration welds - Test entire length of all field welds. Use radiographic or ultrasonic testing techniques.
  - d. Correction for complete weld rejection shall be same as described under shop inspection/testing.
- D. High Strength Bolted Connections:
- 1. The ITL will inspect in accordance with the following:
    - a. AISC specification for structural joists.
    - b. Visually inspect all bolts.
- E. Check for proper torque with calibrated torque wrench:
- 1. Minimum of two (2) bolts of every third connection between floor beams and girders.
  - 2. Minimum of two (2) bolts of every connection between girders and columns.
  - 3. All bolted connections that fail shall be corrected and all bolts in that connection shall be retested.
- F. Metal Deck:
- 1. Verify metal deck is attached to the structural frame in accordance with manufacturer's recommendations and approved shop drawings.

END OF SECTION 051200

**SECTION 052100 STEEL JOIST FRAMING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Open web steel joists and girders, with bridging, attached seats and anchors.
- B. Loose bearing members, such as plates or angles, and anchor bolts for site placement.
- C. Supplementary framing for roof openings greater than 18 inches.

**1.02 RELATED REQUIREMENTS**

- A. Section 05 12 00 - Structural Steel Framing: Superstructure framing.
- B. Section 05 31 00 - Steel Decking: Support framing for openings less than 18 inches in decking.
- C. Section 05 50 00 - Metal Fabrications: Non-framing steel fabrications attached to joists.

**1.03 REFERENCE STANDARDS**

- A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
- B. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.
- C. SJI (SPEC) - Catalog of Standard Specifications and Load Tables for Steel Joists and Joist Girders; Steel Joist Institute.
- D. SJI Technical Digest No. 9 - Handling and Erection of Steel Joists and Joist Girders; Steel Joist Institute.
- E. SSPC-Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; Society for Protective Coatings.
- F. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings.
- G. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

**1.04 SUBMITTALS**

- A. See Section 01 33 00 - Submittals, for submittal procedures.
- B. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, connections, and attachments.
- C. Design and Installation Requirements: Conform to Assembly Design Nos indicated.

**1.05 QUALITY ASSURANCE**

- A. Design connections not detailed on the drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in Kansas.
- B. Perform Work, including that for headers and other supplementary framing, in accordance with SJI Standard Specifications Load Tables and SJI Technical Digest No.9.
- C. Design and Installation Requirements: Conform to UL Assembly Design No. indicated on



the Drawings or required by code.

- D. Manufacturer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.
- E. Erector Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Transport, handle, store, and protect products to SJI requirements.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Open Web Joists: SJI Type K Joists:
  1. Provide top chord extensions as indicated.
  2. End bearing of 2-1/2 inches on steel supports.
  3. Finish: Shop primed, color: standard gray.
- B. Anchor Bolts, Nuts and Washers: ASTM A325 (A 325M).
- C. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A 36/A 36M.
- D. Welding Materials: AWS D1.1; type required for materials being welded.
- E. Shop and Touch-Up Primer: SSPC-Paint 25, zinc oxide, complying with VOC limitations of authorities having jurisdiction.

### **2.02 K-SERIES STEEL JOISTS**

- A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  1. Joist Type: K-series steel joists and KCS-type K-series steel joists
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
- C. Provide holes in chord members for connecting and securing other construction to joists.
- D. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."
- E. Camber joists according to SJI's "Specifications."
- F. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

## 2.04 FABRICATION

- A. General: All joists shall be open-web truss type conforming to the Standard of the Steel Joists Institute, latest edition, and all applicable building codes. Series and spaces of joists shall be as indicated. Top and bottom chords shall consist of double angles. Provide top chord pitch on joist as shown on the Drawings. Joists shall be designed to support a net uplift load as shown on the Drawings.
  - 1. Extended Ends: Provide extended ends on joists where shown, complying with manufacturer's standards, requirements of applicable SJI "Specifications" and load tables.
  - 2. Bridging: Provide diagonal type bridging for open web joists, complying with SJI "Specifications". Provide bridging anchors for ends of bridging lines terminating at walls or beams. Bridging shall consist of bolted or welded cross bracing or horizontal bridging as indicated. L/r shall not exceed 200. Spacing shall conform to Steel Joist Institute Specifications, latest edition.
  - 3. End Anchorage: Provide end anchorages including bearing plates, to secure joists to adjacent construction, complying with SJI "Specifications", unless otherwise indicated.

## 2.05 FINISH

- A. Shop prime joists by removing loose scale, heavy rust and other foreign materials from fabricated joists and accessories before application of shop paint.
  - 1. Apply one shop coat of steel prime paint to joists and accessories, by spray, dipping, or other method to provide a continuous dry paint film thickness of not than 0.50 mil.
  - 2. Do not prime surfaces that will be fireproofed.
  - 3. Color: Standard gray
- B. Prepare surfaces to be finished in accordance with SSPC-SP 2.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify existing conditions prior to beginning work.

### 3.02 ERECTION

- A. Erect joists with correct bearing on supports.
- B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.
- C. Coordinate the placement of anchors for securing loose bearing members furnished as part of the work of this section.
- D. After joist alignment and installation of framing, field weld joist seats to steel bearing surfaces.
- E. Position and field weld joist chord extensions and wall attachments as detailed.
- F. Install supplementary framing for floor and roof openings greater than 9 inches square.
- G. Do not permit erection of decking until joists are braced bridged, and secured or until completion of erection and installation of permanent bridging and bracing.

H. Do not field cut or alter structural members without approval of joist manufacturer.

**3.03 TOLERANCES**

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Alignment: 1/4 inch.

**3.04 FIELD QUALITY CONTROL**

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.
- B. Welded Connections: Visually inspect all field-welded connections and all field bolted connections.
- C. Testing Agency shall report test results promptly and in writing to the Contractor and Architect/Engineer.
- D. Correct deficiencies in work that inspection and test reports have indicated are not in compliance with specification requirements.

END OF SECTION 052100

## **SECTION 053100 STEEL DECKING**

### **PART 1 GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Roof deck.
- B. Supplementary framing for openings up to and including 18 inches square.
- C. Bearing plates and angles.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 05 12 00 - Structural Steel Framing: Support framing for openings larger than 18 inches.
- B. Section 05 21 00 - Steel Joist Framing: Support framing for openings larger than 18 inches.

#### **1.03 REFERENCE STANDARDS**

- A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
- D. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.
- E. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society.
- F. SDI (DM) - Publication No.31, Design Manual for Composite Decks, Form Decks, Roof Decks; Steel Deck Institute.
- G. SSPC-Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; Society for Protective Coatings.

#### **1.04 SUBMITTALS**

- A. See Section 01 33 00 - Submittals, for submittals procedures.
- B. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 6 months.

#### **1.05 QUALITY ASSURANCE**

- A. Design deck layout, spans, fastening and joints in accordance with Steel Deck Institute specifications.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Cut plastic wrap to encourage ventilation.
- B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

### **PART 2 PRODUCTS**

## 2.01 MANUFACTURERS

- A. Steel Deck:
  1. Metal Dek Group: [www.metaldek.com](http://www.metaldek.com)
  2. Canam Steel Corporation: [www.canam-steeljoists.ws](http://www.canam-steeljoists.ws).
  3. Nucor-Vulcraft Group: [www.vulcraft.com](http://www.vulcraft.com).
  4. Wheeling Corrugating Co: [www.wheelingcorrugating.com](http://www.wheelingcorrugating.com).
- B. Substitutions: See Section 01 60 00 - Product Requirements.

## 2.02 ROOF DECK

- A. All Deck Types: Select and design metal deck in accordance with SDI Design Manual.
  1. Calculate to structural working stress design and structural properties specified.
  2. Maximum Vertical Deflection of Floor Deck: 1/360 of span.
  3. Maximum Vertical Deflection of Roof Deck: 1/240 of span.
  4. Maximum Lateral Deflection of Diaphragms: 1/500 of the height of the wall.
- B. Roof Deck: Non-composite type, fluted steel sheet:
  1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), with G60/Z180 galvanized coating.
    - a. Grade as indicated in structural drawings.
  2. Primer: Shop coat of manufacturer's standard gray primer paint over cleaned and phosphatized substrate, bottom surface only.
  3. Minimum Metal Thickness, Excluding Finish: As indicated on the Drawings.
  4. Nominal Height: As indicated on the Drawings.
  5. Deck: Shall be of type indicated on structural drawings. Minimum length of deck shall provide a three span condition over supporting members. The gauge of deck shall be as indicated on the Drawings.
  6. Side Joints: Lock seam - screwed #10 TEKS per manufacturer (36" maximum spacing or as required per contract documents).
  7. End Joints: Lapped, welded at 12 inches o.c. or as required per contract documents.

## 2.03 ACCESSORY MATERIALS

- A. Bearing Plates and Angles: ASTM A 36/A 36M steel, unfinished.
- B. Welding Materials: AWS D1.1.
- C. Shop and Touch-Up Primer: SSPC-Paint 25, zinc oxide, complying with VOC limitations of authorities having jurisdiction. Color: standard gray.
- D. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to the deck.
- E. Acoustical Insulation: Glass fiber type, minimum 1.1 lb/cu ft density; profiled to suit deck.

## 2.05 FABRICATED DECK ACCESSORIES

- A. Sheet Metal Deck Accessories: Metal closure strips and cover plates, 22 gage thick sheet steel; of profile and size as indicated; finished same as deck.
- B. Floor Drain Pans: 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below floor deck surface, bearing flange 3 inches wide, sealed watertight.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify existing conditions prior to beginning work.

### 3.02 INSTALLATION

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, requirements in this Section, and as indicated.
- B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- G. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
- H. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1½ inches (38 mm.)
- I. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.
  - 1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- J. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
  - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

### 3.03 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### 3.04 REPAIRS

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint. areas, and damaged surface coating, with touch-up primer.

END OF SECTION 053100

**SECTION 054000- COLD-FORMED METAL FRAMING****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Non-load bearing cold-formed steel stud exterior wall framing.
- B. Exterior wall sheathing.

**1.02 RELATED REQUIREMENTS**

- A. Section 05 12 00 - Structural Steel: Structural building framing.
- B. Section 05 31 00 - Steel Decking.
- C. Section 07 21 00 - Thermal Insulation: Insulation within framing members.
- D. Section 07 27 26 – Fluid-Applied Membrane Air Barriers.

**1.03 REFERENCE STANDARDS**

- A. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM C 955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
- D. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- E. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.
- F. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.

**1.04 SUBMITTALS**

- A. See Section 013300 - Submittals, for submittal procedures.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
  - 1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 2. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
  - 3. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
- C. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.

- D. Shop drawings must be approved in writing by the Architect before work can begin.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURERS**

- A. Metal Framing, Connectors, and Accessories:
1. Dietrich Metal Framing: [www.dietrichindustries.com](http://www.dietrichindustries.com).
  2. MarinoWare: [www.marinoware.com](http://www.marinoware.com).
  3. MiTek Industries, Inc: [www.mitek-us.com/core.asp](http://www.mitek-us.com/core.asp).
  4. The Steel Network, Inc: [www.SteelNetwork.com](http://www.SteelNetwork.com).
- B. Substitutions: See Section 00 63 25 - Product Substitution Request.

### **2.02 FRAMING SYSTEM**

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B. Metal Framing Connectors and Accessories:
1. Same manufacturer as framing.
  2. The Steel Network Inc: [www.SteelNetwork.com](http://www.SteelNetwork.com).
  3. Substitutions: See Section 01 60 00 - Product Requirements.

### **2.03 FRAMING MATERIALS**

- A. Studs and Track: ASTM C 955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
1. Gage and depth: As required to meet specified performance levels.
  2. Galvanized in accordance with ASTM A 653/A 653M G90/Z275 coating.
- B. Connector Devices:
1. Vertical Deflection Clips: As indicated on Structural Drawings.
  2. Drift System Clips: As indicated on Structural Drawings.
  3. Rigid Clip Angles: As indicated on Structural Drawings.
  4. Roof Ties: As indicated on Structural Drawings.
- C. Bridging:
1. As indicated on Structural Drawings.

### **2.04 SHEATHING**

- A. Wall Sheathing: Glass mat faced gypsum; ASTM C 1177/C 1177M, square long edges, 1/2 inch. Provide Dens Glass Gold manufactured by Georgia Pacific or approved equal.
- B. Parapet Wall Sheathing: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick. Provide Dens Deck manufactured by Georgia Pacific or approved equal.

### **2.05 ACCESSORIES**

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.
- C. Water-Resistive Barrier: As specified in Section 07 27 26.

### **2.06 FASTENERS**



- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A 153/A 153M.
- B. Anchorage Devices: Power actuated.
- C. Welding: In conformance with AWS D1.1.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that substrate surfaces are ready to receive work.

### **3.02 INSTALLATION OF STUDS**

- A. Install components in accordance with manufacturers' instructions.
- B. Align floor and ceiling tracks with wall layout. Secure in place with fasteners as indicated on Structural Drawings. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using clip and tie method.
- D. Construct corners using minimum of three studs. Install minimum double studs at wall openings, door and window jambs unless calculations indicate more are required.
- E. Install studs full length in one piece. Splicing of studs is not permitted.
- F. Install studs, brace, and reinforce to develop full strength and achieve design requirements.
- G. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- H. Install intermediate studs above and below openings to align with wall stud spacing.
- I. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- J. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- K. Touch-up field welds and damaged galvanized surfaces with primer.

### **3.03 FRAMING ACCESSORY INSTALLATION**

- A. Install accessories as required by structural design calculations. Provide appropriate fasteners in all predrilled holes backed by another framing member.

### **3.04 WALL SHEATHING**

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
  - 1. Place water-resistant barrier horizontally over wall sheathing, weather lapping edges and ends.

### **3.05 PARAPET SHEATHING**

- A. Parapet Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.

### **3.06 TOLERANCES**

- A. Maximum Variation from True Position: 1/8 inch.
- B. Maximum Variation of any Member from Plane: 1/8 inch.

END OF SECTION 054000

**SECTION 055000 - METAL FABRICATIONS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Steel framing and supports for countertops.
  - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  - 3. Metal ladders.
  - 4. Metal bollards.
- B. Products furnished, but not installed, under this Section include the following:
  - 1. Loose steel lintels.
  - 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
  - 3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
  - 2. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
  - 3. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.

**1.3 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
  - 2. Fasteners.
  - 3. Shop primers.
  - 4. Shrinkage-resisting grout.
  - 5. Manufactured metal ladders.
  - 6. Metal bollards.
  
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
  - 1. Steel framing and supports for countertops.
  - 2. Steel framing and supports for mechanical and electrical equipment.
  - 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  - 4. Metal ladders.
  - 5. Metal bollards.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

#### **1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel".
  - 2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel"

#### **1.7 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### **2.2 METALS**

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A 36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A 276/A 276M, Type 304.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

### **2.3 FASTENERS**

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless steel fasteners for fastening stainless steel.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1 (A1).
- D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
  - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in

concrete, as determined by testing in accordance with ASTM E 488/E 488M, conducted by a qualified independent testing agency.

- F. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329/F 2329M.
- G. Post-Installed Anchors: Torque-controlled expansion anchors.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F 593, and nuts, ASTM F 594.
- H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

## 2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099123 "Painting."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
  - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

## 2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain

structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

## **2.6 MISCELLANEOUS FRAMING AND SUPPORTS**

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.

- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

## **2.7 SHELF ANGLES**

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
  - 1. Provide mitered and welded units at corners.
  - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.
- D. Prime shelf angles located in exterior walls with zinc-rich primer.
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

## **2.8 METAL LADDERS**

- A. General:
  - 1. Comply with ANSI A14.3, except for elevator pit ladders.
  - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
  - 1. Space siderails 16 inches apart unless otherwise indicated.
  - 2. Siderails: Continuous, 3/8-by-2-1/2-inch steel flat bars, with eased edges.
  - 3. Rungs: 3/4-inch-diameter steel bars.
  - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
  - 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
  - 6. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch in least dimension.
  - 7. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
  - 8. Galvanize and prime ladders, including brackets.
  - 9. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.



**2.9 MISCELLANEOUS STEEL TRIM**

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime miscellaneous steel trim.
- D. Prime miscellaneous steel trim with zinc-rich primer.

**2.10 METAL BOLLARDS**

- A. Unless otherwise indicated, fabricate metal bollards from Schedule 40 steel pipe 1/4-inch wall-thickness steel shapes, as indicated.
  - 1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
  - 2. Where bollards are indicated to receive stainless steel covers, provide Schedule 10, 316 Stainless Steel with Brushed #4 finish and 45-degree slant top.
- B. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch-thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- C. Galvanize and prime bollards with zinc-rich primer.

**2.11 LOOSE BEARING AND LEVELING PLATES**

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with zinc-rich primer.

**2.12 LOOSE STEEL LINTELS**

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

- C. Galvanize and prime loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

### **2.13 STEEL WELD PLATES AND ANGLES**

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

### **2.14 GENERAL FINISH REQUIREMENTS**

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

### **2.15 STEEL AND IRON FINISHES**

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Cast Aluminum: Heavy coat of bituminous paint.
  - 2. Extruded Aluminum: Two coats of clear lacquer.

### **3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS**

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors and overhead grilles securely to, and rigidly brace from, building structure.

### **3.3 INSTALLING METAL BOLLARDS**

- A. Fill bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with non-shrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- D. Fill bollards solidly with concrete, mounding top surface to shed water.

**3.4 INSTALLATION OF BEARING AND LEVELING PLATES**

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

**3.5 REPAIRS**

- A. Touchup Painting:
  - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

**SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Rooftop equipment bases and support curbs.
  - 2. Wood blocking, cants, and nailers.
  - 3. Wood furring and grounds.
  - 4. Utility shelving.
  - 5. Plywood backing panels.

**1.3 DEFINITIONS**

- A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
  - 2. NHLA: National Hardwood Lumber Association.
  - 3. NLGA: National Lumber Grades Authority.
  - 4. SPIB: The Southern Pine Inspection Bureau.
  - 5. WCLIB: West Coast Lumber Inspection Bureau.
  - 6. WWPA: Western Wood Products Association

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
  - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Evaluation Reports: For the following, from ICC-ES:
  - 1. Preservative-treated wood.
  - 2. Fire-retardant-treated wood.
  - 3. Power-driven fasteners.

4. Post-installed anchors.
5. Metal framing anchors.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## PART 2 - PRODUCTS

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
  3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

### 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground.
  1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
  2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
  1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.
- D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, blocking and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of concrete walls.
4. Blocking at toilets, lavatories, sinks, and other plumbing fixtures

### **2.3 FIRE-RETARDANT-TREATED MATERIALS**

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  1. Use treatment that does not promote corrosion of metal fasteners.
  2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
  3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
  4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
  1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.
- E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat all miscellaneous carpentry unless otherwise indicated including, but not limited to the following:
  1. Concealed blocking.
  2. Roof framing and blocking.
  3. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
  4. Plywood backing panels.

### **2.4 MISCELLANEOUS LUMBER**

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  1. Blocking.
  2. Nailers.
  3. Rooftop equipment bases and support curbs.
  4. Cants.

5. Furring.
  6. Utility shelving.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
- C. For utility shelving, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
  2. Mixed southern pine, No. 1 grade; SPIB.
- D. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine, No. 3 grade; SPIB.
  2. Eastern softwoods, No. 3 Common grade; NELMA.
  3. Northern species, No. 3 Common grade; NLGA.
  4. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.
- E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## **2.5 PLYWOOD BACKING PANELS**

- A. Equipment Backing Panels: DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

## **2.6 FASTENERS**

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.



1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

## 2.7 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
  1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch thick.
  1. Use for wood-preservative-treated lumber and where indicated.

## 2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
  1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  1. Provide metal clips for fastening gypsum board at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- F. Provide fire blocking in furred spaces, and other concealed cavities as indicated and as follows:
  1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
- G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with

function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. NES NER-272 for power-driven fasteners.
  - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

### **3.2 WOOD BLOCKING AND NAILER INSTALLATION**

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

### **3.3 PROTECTION**

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

## **SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Plastic-laminate cabinets.
  - 2. Plastic-laminate countertops.
  - 3. Wood-veneer faced panels.
  - 4. Solid surface countertops.
  - 5. Shelving and coat rod.
- B. Related Sections include the following:
  - 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

#### **1.3 DEFINITIONS**

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

#### **1.4 SUBMITTALS**

- A. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, fire-retardant-treated materials, cabinet hardware and accessories and finishing materials and processes.
  - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  - 1. Show details full size.
  - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 3. Show locations and sizes of cutouts and holes for electrical outlets and plumbing fixtures and other items installed in architectural woodwork.
- C. Samples for Verification:
  - 1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.

2. Thermoset decorative-panels, 8 by 10 inches, for each type, color, pattern, and surface finish, with edge banding on one edge.
  3. Solid surface countertop material
- D. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- E. Qualification Data: For Installer fabricator.

## **1.5 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of products.
- C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

## **1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.
  2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## 1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
1. Hardboard: AHA A 135.4.
  2. Medium-Density Fiberboard: ANSI A 208.2, Grade MD.
  3. Particleboard: ANSI A 208.1, Grade M-2.
  4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
1. Plastic Laminate-1 (**PL-1**)
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to approved by Architect prior to bid:  
Manufacturer: Wilsonart Laminates, Color: Walnut Heights 7965K-12
    - b. Acceptable Comparable Products:
      - 1) Manufacturer: Arborite, Color: Summer Elm W459LE
      - 2) Manufacturer: Formica, Color: Natural Teak 8849-58 Matte Finish
  2. Plastic Laminate-2 (**PL-2**)
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to approved by Architect prior to bid:  
Manufacturer: Wilsonart Laminates, Color: Pepperdust D327-60 Matte Finish
    - b. Acceptable Comparable Products:
      - 1) Manufacturer: Pionite, Color: Stonedust Suede SG224-S
      - 2) Manufacturer: Nevamar, Color: Bethany Beige S2069T
  3. Plastic Laminate-3 (**PL-3**)
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to approved by Architect prior to bid:  
Manufacturer: Wilsonart Laminates, Color: Handspun Chestnut 5036-38 Fine Velvet Finish
    - b. Acceptable Comparable Products:
      - 1) Manufacturer: Arborite, Color: Urban Day P392CA
      - 2) Manufacturer: Nevamar, Color: Cool Chic VA7002T
- D. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semi exposed edges.

E. Solid Surface:

1. Solid Surface -1 (**SS-1**)
  - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to approved by Architect prior to bid:  
Manufacturer: Corian Solid Surfaces, Collection: Carrara Lino
  - b. Acceptable Comparable Products:
    - 1) Manufacturer: Avonite, Surfaces, Collection: Cielo, Style: 6740, Satin Finish
    - 2) Manufacturer: LG Hausys, Collection: Hi-Macs, Style: M603 Aurora Pavia
2. Solid Surface-2 (**SS-2**)
  - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to approved by Architect prior to bid:  
Manufacturer: Corian Solid Surfaces, Collection: Concrete
  - b. Acceptable Comparable Products:
    - 1) Manufacturer: Wilsonart Solid Surfaces, Collection: Masoned Concrete 9252SS
    - 2) Manufacturer: LG Hausys, Collection: Hi-Macs, Style: M551 Chic Concrete

## 2.2 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Frameless Concealed Hinges (European Type): BHMA A 156.9, B 01602, 135 degrees of opening, self-closing.
- C. Wire Pulls: For P-Lam cabinets: Back mounted, solid metal, 3 1/2" wire pull, satin nickel finish.
- D. Catches: Magnetic catches, BHMA A 156.9, B03141.
- E. Adjustable Shelf Standards and Supports: BHMA A 156.9, B03141.
- F. Lock systems: Heavy-duty cam locks with two keys per lock and master key.
- G. Aluminum garment hooks on sidewall of locker.
- H. Polished chrome clothes rod.
- I. Drawer Slides: BHMA A 156.9, B05091.
  1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension soft-close type; zinc-plated steel ball-bearing slides.
  2. Box Drawer Slides:
    - a. Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide and less.

- b. Grade 1HD-100; for drawers Wider than 24 inches.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
  - 1. Satin Chromium Plated: BHMA 626 for brass or bronze bass, BMHA 652 for steel base.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

### **2.3 MISCELLANEOUS MATERIALS**

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- B. Counter Support Brackets: Basis of Design: Rakks EH-1818 (or as sized for counter depth), black powder coated.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- D. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
  - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified for faces.

### **2.4 FABRICATION, GENERAL**

- A. Interior Woodwork Grade: Unless otherwise indicated, provide custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Fabricate woodwork to dimensions, profiles, and details indicated.
- D. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
- E. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
  - 1. Seal edges of openings in countertops with a coat of varnish.

### **2.5 PLASTIC-LAMINATE CABINETS**

- A. Grade: Custom.
- B. Type of Construction: Frameless.
- C. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.

- D. Reveal Dimension: 1/2 inch.
- E. Laminate Cladding for Exposed Surfaces:
  - 1. Horizontal Surfaces: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade HGS.
  - 4. Edges: Grade HGS or PVC edge banding, 0.12 inch thick, matching laminate in color, and finish.
- F. Materials for Semiexposed Surfaces:
  - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
    - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
    - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
  - 2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
  - 3. Drawer Bottoms: Thermoset decorative panels.
- G. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

## **2.6 PLASTIC-LAMINATE COUNTERTOPS**

- A. Grade: Custom.
- B. High-Pressure Decorative Laminate Grade: HGS.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As scheduled on Drawings.
- D. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- E. Core Material: Particleboard; ANSI A208.1, Grade M-2-Exterior Glue.
- F. Core Material at Sinks: Particleboard; ANSI A208.1, Grade M-2-Exterior Glue.
- G. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

## **2.7 SOLID-SURFACE-MATERIAL COUNTERTOPS**

- A. Countertops: 3 cm thick, solid surface material with front edge built up with same material.
- B. Outside corners shall have 1" radius.



- C. Back and Side Splashes: 1/2-inch-thick, solid surface material.
- D. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
  1. Fabricate with loose backsplashes for field assembly.

## **2.8 SHELVING AND COAT ROD**

- A. Closet Shelving: Made from one of the following materials, 3/4 inch thick.
  1. Particleboard with radiused and filled front edge.
  2. MDF with radiused front edge.
  3. Melamine-faced particleboard with radiused and filled front edge.
- B. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
- C. Clothes Rods: 1-5/16-inch- diameter, chrome-plated-steel tubes.
- D. Rod Flanges: Chrome-plated steel.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

### **3.2 INSTALLATION**

- A. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- B. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- C. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- F. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
  2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
  4. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

### **3.3 ADJUSTING AND CLEANING**

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

**SECTION 072100 - THERMAL INSULATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  1. Extruded polystyrene foam-plastic board.
  2. Polyisocyanurate foam-plastic board
  3. Glass-fiber blanket.
  4. Mineral-wool
  5. Vapor retarders.
- B. Related Requirements:
  1. Section 075423 "Thermoplastic-Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
  2. Section 092900 "Gypsum Board Assemblies" for sound attenuation blanket used as acoustic insulation.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

**1.5 QUALITY ASSURANCE**

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
  1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
  3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## **PART 2 - PRODUCTS**

### **2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD**

- A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics
- B. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
  - 1. Type VII, 60psi min.
  - 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
  - 3. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. DiversiFoam Products
  - 4. Acceptable Manufacturers:
    - a. Dow Chemical Company
    - b. Johns Manville
    - c. Owens Corning
    - d. Atlas Foam-Control Plus
- C. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

### **2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD**

- A. Polyisocyanurate Board, Glass-Fiber-Mat Faced: ASTM C 1289, glass-fiber-mat faced, Type II, Class 2.
  - 1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Johns Manville
  - 3. Acceptable Manufacturers:
    - a. Dow Chemical Company
    - b. DiversiFoam Products
    - c. Owens Corning
    - d. Hunter Panels
- B. Polyisocyanurate Board, Foil-Faced Rigid Foam Sheathing: ASTM C 1289, Type I, Class 1.
  - 1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Johns Manville
  - 3. Acceptable Manufacturers:
    - a. Dow Chemical Company
    - b. DiversiFoam Products
    - c. Owens Corning
    - d. Hunter Panels

- C. Continuous Exposed Interior Wall Insulation Panels
1. Closed-cell Class A polyisocyanurate foam core with 15-mil thick reinforced foil facers, one side reflective, one side with white acrylic coating. Type II per ASTM C 1289.
  2. Flame Spread Index: ASTM E 84, less than 25.
  3. Smoke Developed: ASTM E 84, less than 250.
  4. Panel Size: 4 feet by 8 feet.
  5. Thickness: 1.5 inches / R-Value 9.3
  6. Joint Finishing: Per manufacturer recommendations to achieve IBC thermal barrier requirements.
  7. Fastening Method: Insulation retainment systems for exposed applications.
  8. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Johns Manville
      - 1) CI Max Polyisocyanurate Foam Sheathing Board
  9. Acceptable Manufacturers:
    - a. Hunter Panels
    - b. Dow Chemical Company

### 2.3 GLASS-FIBER BLANKET

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
  1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- C. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
  1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
  2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

### 2.4 MINERAL-WOOL BLANKETS

- A. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Owens Corning
  2. Acceptable Manufacturers:
    - a. Industrial Insulation Group
    - b. Johns Manville
    - c. Roxul Inc

### 2.5 VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D 4397, 10 mils thick, with maximum permeance rating of 0.13 perm.
- B. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or

polyester scrim and weighing not less than 22 lb/1000 sq. ft., with maximum permeance rating of 0.1317 perm and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively, per ASTM E 84.

- C. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- D. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
- E. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
- F. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

## 2.6 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
  - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
  - 1. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
  - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
- D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

## 2.7 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
  - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
  - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
  - 1. Adhesives shall have a VOC content of 70g/L or less.

**PART 3 - EXECUTION****3.1 PREPARATION**

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

**3.2 INSTALLATION, GENERAL**

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

**3.3 INSTALLATION OF SLAB INSULATION**

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
  - 1. If not otherwise indicated, extend insulation a minimum of 30 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
  - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

**3.4 INSTALLATION OF FOUNDATION WALL and BELOW-GRADE INSULATION**

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
  - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
  - 2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
  - 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
  - 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### 3.5 **INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION**

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
  5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
  2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- C. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

### 3.6 **INSTALLATION OF VAPOR RETARDERS**

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
  1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
  2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
  3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.



**3.7 PROTECTION**

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

**SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Vapor-permeable, fluid-applied air barriers.
- B. Related Requirements:
  - 1. Section 074243 "Composite Wall Panels" for accessories and materials required for composite wall panel systems.

**1.3 DEFINITIONS**

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

**1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; dry film thickness; and tested physical and performance properties of products.
- B. Shop Drawings: For air-barrier assemblies.
  - 1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
  - 2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
  - 3. Include details of interfaces with other materials that form part of air barrier.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
- B. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.
- C. Field quality-control reports.

**1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
  - 1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.
- B. Mockups: Build mockups to set quality standards for materials and execution.
  - 1. Build integrated mockups of exterior wall assembly, 16sf minimum, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
    - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
    - b. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

**1.9 FIELD CONDITIONS**

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.
  - 1. Protect substrates from environmental conditions that affect air-barrier performance.
  - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and complying with VOC content limits of authorities having jurisdiction.

**2.2 PERFORMANCE REQUIREMENTS**

- A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E 283, ASTM E 783 or ASTM E 2357.

### 2.3 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

- A. Vapor-Permeable Air Barrier: Fluid-applied, modified bituminous or synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 30 mils or thicker cured over smooth, void-free substrates.
- B. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: Elastomeric, modified bituminous or synthetic polymer membrane.
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Elastomeric, Modified Bituminous Membrane:
      - 1) Henry Company; Air-Bloc 07.
    - b. Synthetic Polymer Membrane:
      - 1) Carlisle Coatings & Waterproofing Inc.; Barritech VP.
  - 2. Acceptable Manufacturers:
    - a. Elastomeric, Modified Bituminous Membrane:
      - 1) Hohmann & Barnard, Inc.; Textroflash Liquid VP.
      - 2) Meadows, W. R., Inc.; Air-Shield LMP.
      - 3) Tremco Incorporated, an RPM company; ExoAir 220R.
    - b. Synthetic Polymer Membrane:
      - 1) Grace, W. R., & Co. - Conn.; Perm-A-Barrier VP.
      - 2) Henry Company; Air-Bloc 33.
      - 3) Rubber Polymer Corporation, Inc.; Rub-R-Wall Airtight VP.
      - 4) Tremco Incorporated, an RPM company; ExoAir 230.
  - 3. Physical and Performance Properties:
    - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
    - b. Vapor Permeance: Minimum 10 perms or less and greater than 1.0 perm; ASTM E 96/E 96M.
    - c. Ultimate Elongation: Minimum 200 percent; ASTM D 412, Die C.
    - d. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
    - e. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541.
    - f. UV Resistance: Can be exposed to sunlight for 90 days according to manufacturer's written instructions.

### 2.4 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.
- C. Stainless-Steel Sheet: ASTM A240/A240M, Type 304, 0.0187inch thick, and Series 300 stainless-steel fasteners.
- D. Transition Flashing: 40 mil SBS modified bitumen self-adhering membrane with a cross-laminated polyethylene film for window and door sill flashing, door openings, inside and outside corners and other transitions as provided by the manufacturer.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
  - 2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
  - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  - 4. Verify that masonry joints are flush and completely filled with mortar.

### **3.2 SURFACE PREPARATION**

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.
- H. Bridge discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

### **3.3 ACCESSORIES INSTALLATION**

- A. Install accessory materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
  - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
  - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
  - 3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
  - 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Re-prime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window

systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

- C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.
- D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
  - 1. Transition Strip: Roll firmly to enhance adhesion.
- F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- H. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, transition strip.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counter-flashings or ending in reglets with termination mastic.
- J. Seal joints  $\frac{1}{4}$  inch and less between panels of glass mat sheathing or plywood with joint treatment sealant. Seal gaps and voids or irregular joints greater than  $\frac{1}{4}$  inch between panels of glass mat sheathing or plywood with a strip of self-adhering air/vapor barrier transition membrane lapped a minimum of  $1\frac{1}{2}$  inches on both sides unless otherwise recommended by manufacturer.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

### 3.4 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

- A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
  - 1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
  - 2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
  - 3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.
- B. Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply air-barrier material in full contact around protrusions such as masonry ties.
  - 1. Vapor-Permeable, Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, but not less than 30 mils, applied in one or more equal coats.
- C. Do not cover air barrier until it has been tested and inspected by testing agency.
- D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

### 3.5 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements.
  - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
  - 2. Air-barrier dry film thickness.
  - 3. Continuous structural support of air-barrier system has been provided.
  - 4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
  - 5. Site conditions for application temperature and dryness of substrates have been maintained.
  - 6. Maximum exposure time of materials to UV deterioration has not been exceeded.
  - 7. Surfaces have been primed, if applicable.
  - 8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
  - 9. Termination mastic has been applied on cut edges.
  - 10. Strips and transition strips have been firmly adhered to substrate.
  - 11. Compatible materials have been used.
  - 12. Transitions at changes in direction and structural support at gaps have been provided.
  - 13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
  - 14. All penetrations have been sealed.
- D. Tests: As determined by testing agency from among the following tests:
  - 1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
  - 2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.
  - 3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 1000 sq. ft. of installed air barrier or part thereof.
- E. Air barriers will be considered defective if they do not pass tests and inspections.
  - 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
  - 2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

### 3.6 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
  - 1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-

barrier application after repairing and preparing the overexposed materials according to air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
  - C. Remove masking materials after installation.

END OF SECTION 072726



## **SECTION 074243 - COMPOSITE WALL PANELS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. composite wall panel dry joint, pressure equalized rainscreen system.
  - 2. Accessories including sub grits, aluminum panel splines, aluminum panel bases, head flashings, clips, shims, fasteners, and aluminum trim prefinished to match aluminum wall panels.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Owner's insurer if applicable, composite material panel Installer, composite material panel manufacturer's representative, and installers whose work interfaces with or affects composite material panels.
  - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 3. Review methods and procedures related to composite material panel installation, including manufacturer's written instructions.
  - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect composite material panels.
  - 6. Review temporary protection requirements for composite material panel assembly during and after installation.
  - 7. Review procedures for repair of panels damaged after installation.
  - 8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
  - 1. Include fabrication and installation layouts of composite material panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
  - 2. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Initial Selection: For each type of composite material panel indicated with factory-applied color finishes.
  - 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Engineering Calculations: Submit engineering calculations as required by the local building code, showing that the installed panels and attachments system meets the wind load requirements of the project.
- C. Product Test Reports: For each product, tests performed by a qualified testing agency.
- D. Field quality-control reports.
- E. Sample Warranties: For special warranties.

**1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For composite material panels to include in maintenance manuals.

**1.7 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: All primary panel products specified in this section will be supplied by a single manufacturer with a minimum of ten years experience.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- C. Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- D. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup of typical composite material panel assembly as part of exterior mockup, including corner supports, attachments, and accessories.
  - 2. Water-Spray Test: Conduct water-spray test of mockup of composite material panel assembly, testing for water penetration according to AAMA 501.2.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver components, composite material panels, and other manufactured items so as not to be damaged or deformed. Package composite material panels for protection during transportation and handling.
- B. Unload, store, and erect composite material panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack composite material panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store composite material panels to ensure dryness, with positive slope for drainage of water. Do not store composite material panels in contact with other materials that might cause staining, denting, or other surface damage.

- D. Retain strippable protective covering on composite material panels during installation.

### **1.9 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of composite material panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify actual measurements/openings by field measurements performed by the installer prior to release for fabrication. Recorded measurements to be indicated on shop drawings based on field measurements provided by the installer. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

### **1.10 COORDINATION**

- A. Coordinate composite material panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

### **1.11 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of composite material panel systems that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of materials beyond normal weathering.
  2. Warranty Period: ten years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace composite material panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Finish Warranty Period: 20 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide composite material panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E330:
  1. Wind Loads: per region.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
  1. Test-Pressure Difference: 1.57 lbf/sq. ft.
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
  1. Test-Pressure Difference: 2.86 lbf/sq. ft.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint

sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces

## 2.2 COMPOSITE PANEL MATERIALS (ACM-1)

### A. Manufacturers:

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Northclad ACM – Rout-and-Return open joint system.
2. Acceptable Manufacturers:
  - a. Pac-Clad PAC-3000 RS Composite Wall Panel
  - b. Alucobond PLUS Exterior

### B. Composition:

1. Aluminum composite material comprised of a thermoplastic core sandwiched between two aluminum sheets formed in a continuous process with no applied glues or adhesives.

### C. Tolerances:

1. Panel bow not to exceed L/175 of panel overall dimension in width or length.
2. Panel dimensions allow for field adjustment and thermal movement.
3. Panel lines will be sharp, smooth, and free from warps or buckles.

### D. Condition: Panel surfaces will be free of scratches and marks caused during fabrication.

### E. Uniformity:

1. If metallic color used, panel grain must be maintained.

### F. Vapor Management: Fabricate panels for control of condensation and ventilation of the rainscreen cavity.

### G. Expansion/Contraction: Engineer panels to permit required expansion and contraction using concealed anchors.

### H. Strippable Protective Film: Factory applied for protection of weather face finish and removed upon completion of the panel installation. Failure to remove the film may lean to over-exposure and damage to the panel.

## 2.3 FASTENERS

### A. Supply fasteners and clips tested to meet provisions of this section, as approved by fastener manufacturer and engineer of record.

### B. Exposed Fasteners:

1. Stainless steel blind unless recommended by the panel manufacturer.
2. Construction Fasteners, Inc., ZAC, self-drilling, self-tapping, non-corrosive fasteners with heads finished to match panel finishes and flashings, gasketed with EPDM washers, and as indicated by manufacturer.

- C. Concealed Sheet Metal Fasteners: Panhead, self-drilling, self-tapping, non-corrosive fasteners, and as instructed by manufacturer and engineer of record.
- D. Fastener Lengths: Penetrate into cold formed metal framing and subgirts, and other metal framing systems per fastener manufacturer's recommendations.

## 2.4 SYSTEM COMPONENTS

- A. Subgirts:
  1. Provide G90 galvanized steel of gauge and spacing required for metal wall panel system structural requirements and as recommended by the panel manufacturer and engineer of record in accordance with approved shop drawings.
  2. To avoid galvanic reaction, separate dissimilar materials.

## 2.5 FLASHINGS

- A. Metal Flashing, Fascias, and Trim:
  1. 0.032-inch minimum thickness.
  2. Material, color, and finish to match wall panels.
- B. Panel and Flashing Closures: Waterproof, semi-rigid, polyethylene closed cell foam, or solid rubber in size and shape to snugly fit panel configuration. C. Cutting and Fitting:
  1. Make all cuts neat, square, and true.
  2. Saw-cut or rout panels, de-burr edges, and clean filings from adjacent surfaces.

## 2.6 SEALANTS

- A. Conform to Section 07 92 00 and manufacturers' instructions.

## 2.7 FINISH

- A. Panel Finishes:
  1. Utilize coating with a fluoropolymer coating with 70% Kynar® 500 resins.
  2. Select colors from manufacturer's standard colors.
  3. Pencil Hardness - ASTM D3352-74: Use an Eagle Turquoise HB-H pencil as a minimum.
- B. Impact Adhesion - ASTM D294-84: No cracking or loss of adhesion in coating.
- C. Cure Test - NCCA 11-18: Withstand 50+ double rubs of MEK.
- D. Humidity Resistance ASTM D2247-85: No blisters after 3,000 hours of 100% humidity at 95 degrees Fahrenheit.
- E. Salt Spray Resistance - ASTM B117-85: After 3,000 hours of exposure to 5 percent salt fog at 95 degrees Fahrenheit, show few #8 blisters and less than 1/8" average creepage from scribe.
- F. Weatherometer Test - ASTM D882-86/G23-88: No cracking, peeling, blistering, or loss of adhesion after 2,000 hours in coating.

- G. Chalking Resistance - ASTM D659-86: No chalking greater than #8 after 10 years of Florida exposure at 45 degrees S.
- H. Color Change - ASTM D2244-74: Color change not to exceed 5 NBS units after 10 years of Florida exposure at 45 degrees S for 5,000 hours.
- I. Abrasion Resistance - ASTM D968-81: Resist 65+/-15 liters/mil minimum of falling sand on coating.
- J. Color: Select from the full range of manufacturers' standard colors.
- K. Anodized Finish (if specified):
  - 1. Class 1, Clear Anodic Finish: AA-M12C22A41 (mechanical finish: nonspecular as fabricated; chemical finish: etched, medium matte; anodic coating: Architectural Class 1, clear coating 0.018 mm or thicker) complying with AAMA 607.1.
  - 2. Class 1, Clear Anodic Finish: AA-M12C22A44 (mechanical finish: nonspecular as fabricated; chemical finish: etched, medium matte; anodic coating: Architectural Class 1 integrally colored or electrolytically deposited color coating 0.018 mm or thicker complying with AAMA 606.1 or AAMA 608.1.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify installation conditions satisfactory to receive work of this Section before beginning.
- B. Verify substrate installation complete, flat, and true to plane.

#### **3.2 PREPARATION**

- A. Field Measurements: Verify prior to fabrication of metal panels and flashings.
- B. Electrolytic Protection: Treat contacting surfaces of dissimilar metal of different galvanic range with non-absorptive tape, gaskets, or as instructed by manufacturer.
- C. Protect surrounding areas and surfaces to preclude damage during work of this Section.
- D. Lay out work before beginning installation as necessary for true, plumb, and aligned panel installations. Verify locations of joints and panel lengths.

#### **3.3 INSTALLATION**

- A. Conform to manufacturer's instructions and provisions of Contract Documents.
- B. Install to allow thermal movement of metal panels.

#### **3.4 SUBGIRTS AND FASTENERS**

- A. Space, locate, align, and fasten subgirt hat channel framing over gypsum sheathing after application of air barrier specified by Section 07 27 26.

- B. Install fasteners in lengths and locations required in order to penetrate hat channels and structural metal wall framing in accordance with fastener manufacturers' instructions.
- C. Torque screws as necessary for a snug fit. Do not over-torque; prevent 'oil canning' of panels.

### **3.5 METAL WALL PANELS**

- A. Lock panels in place to engage interlocking seams.
- B. Do not stretch or compress interlocks.
- C. Secure panels in place with panels aligned and without warp or deflection.
- D. Make cutting and fitting neat, square, and true. Where required saw cut, de-burr edges, and clean filings from adjacent surfaces. No torch cutting permitted.

### **3.6 PANEL GIRTS AND FASTENERS**

- A. Space, locate, and align for even distribution of exposed fasteners, as instructed by manufacturer and engineer of record.
- B. Install fasteners in lengths and locations required to penetrate per fastener manufacturers' instructions.
- C. Torque screws as necessary for snug fit. Do not over-torque; prevent damage to panels.

### **3.7 FLASHINGS**

- A. Install flashings as part of manufactured system as necessary to seal and close ends and to restrict water penetration behind wall panels.
- B. Thermal Movement: Install flashing systems to allow unrestricted thermal movement of metal panels over attachment clips.
- C. Penetrations: Make cutouts and edge clearances of sufficient size and shape to allow unrestrained thermal movement and to prevent contact of metal panels with penetrations.
- D. Metal Flashing: Make overlaps minimum 4 inches and in conformance to Section 07 60 00.
- E. Cutting and Fitting: Make neat, square, and true. Saw-cut panels or rout, de-burr edges, and clean filings from adjacent surfaces.

### **3.8 ADJUSTING**

- A. Correct identified defects and irregularities.

### **3.9 CLEANING**

- A. Leave installation clean and free from residue and debris from work of this Section.

**3.10 PROTECTION**

- A. Take measures to protect metal panel installations from construction activities for duration of Project. Do not permit activities that may result in gouging, scratching, or denting metal panels and flashing.

END OF SECTION 074243



## **SECTION 075423 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Mechanically fastened, thermoplastic polyolefin (TPO) roofing system.
  2. Roof insulation.
  3. Cover board.
  4. Walkways.
- B. Related Requirements:
  1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
  2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
  3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

#### **1.3 DEFINITIONS**

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Roofing Conference: Conduct conference at Project site.
  1. Meet with Owner, Architect, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
  5. Review structural loading limitations of roof deck during and after roofing.
  6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
  7. Review governing regulations and requirements for insurance and certificates if applicable.
  8. Review temporary protection requirements for roofing system during and after installation.
  9. Review roof observation and repair procedures after roofing installation.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
  1. Layout and thickness of insulation.
  2. Base flashings and membrane termination details.
  3. Flashing details at penetrations.
  4. Tapered insulation layout, thickness, and slopes.
  5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
  6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  7. Tie-in with adjoining air barrier.
- C. Samples for Verification: For the following products:
  1. Roof membrane and flashings, of color required.
  2. Aggregate ballast in gradation and color required.
  3. Walkway pads or rolls, of color required.
- D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
  1. Submit evidence of compliance with performance requirements.
- C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Sample Warranties: For manufacturer's special warranties.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For roofing system to include in maintenance manuals.

## **1.8 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

#### **1.10 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

#### **1.11 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of roofing system.
  2. Warranty Period: 30 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, and walkway products, for the following warranty period:
  1. Warranty Period: Five years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
  1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
  2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
  - A. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
    1. Fire/Windstorm Classification: Class 1A-105.
    2. Hail-Resistance Rating: SH.
  - B. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- C. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

## **2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING**

- A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.
- B. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  1. Firestone, UltraPly TPO Membrane
- C. Acceptable Manufacturers:
  1. Carlisle Syntec Systems, Sure-Weld TPO
  2. GAF, EverGuard TPO
  3. Johns Manville, TPO Roofing
- D. Roofing System:
  1. Membrane: Thermoplastic Polyolefin (TPO)
  2. Thickness: 60 mils, nominal.
  3. Exposed Face Color: Gray.
  4. Mechanically fastened.
- E. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as membrane roofing.

## **2.3 AUXILIARY ROOFING MATERIALS**

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
  1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard.
- E. Slip Sheet: Manufacturer's standard, of thickness required for application.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.
- J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.

## 2.4 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated. Required to meet ASHRA 90.1 2013 and provide minimum R-30 value.
- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
- B. Expanded polystyrene board insulation, 60 psi minimum at pavers locations. EPS insulation should be acceptable to roofing manufacturer.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated. 60 psi minimum at paver locations.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.5 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
  - 2. Full-spread spray-applied, low-rise, two-component urethane adhesive.
- C. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick. 60 psi minimum at pavers and green roof system locations.
- D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

## 2.6 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III or Type IV.
- B. Asphalt Primer: ASTM D 41/D 41M.

## 2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
  - 1. Size: Approximately 36 by 60 inches.
  - 2. Color: Contrasting with roof membrane.
- B. At Contractor Option: Provide additional layer of 60 mil TPO roofing in 6' wide strips for paths in contrasting color to roof membrane.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
  - 1. Submit test result within 24 hours after performing tests.
    - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

### **3.3 ROOFING INSTALLATION, GENERAL**

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

### **3.4 INSULATION INSTALLATION**

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
  - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows.
    - a. Locate end joints over crests of decking.
    - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.

- e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches .
    - 1) Trim insulation so that water flow is unrestricted.
  - f. Fill gaps exceeding 1/4 inch with insulation.
  - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - h. Loosely lay base layer of insulation units over substrate.
  - i. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
    - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
    - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
  - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
  - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - f. Fill gaps exceeding 1/4 inch with insulation.
  - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - h. Loosely lay each layer of insulation units over substrate.
  - i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
    - 1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    - 2) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

### 3.5 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
  - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 2. At internal roof drains, conform to slope of drain sump.
    - a. Trim cover board so that water flow is unrestricted.
  - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
  - 4. Loosely lay cover board over substrate.
  - 5. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
    - a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    - b. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

6. To be installed at all roof locations.

B. Install slip sheet over cover board and beneath roof membrane.

### **3.6 MECHANICALLY FASTENED ROOFING INSTALLATION**

A. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.

D. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

E. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

F. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within seam, and mechanically fasten TPO sheet to roof deck.

I. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.

2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

J. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

### **3.7 BASE FLASHING INSTALLATION**

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### **3.8 WALKWAY INSTALLATION**

A. Flexible Walkways:

1. Install flexible walkways at the following locations:

a. Locations indicated on Drawings.

b. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch clearance between adjoining pads.



3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform one of the following tests:
  1. Flood Testing: Flood test each roof area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
    - a. Perform tests before overlying construction is placed.
    - b. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
    - c. Flood each area for 24 hours.
    - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
      - 1) Cost of retesting is Contractor's responsibility.
    - e. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.
  2. Electrical Capacitance/Impedance Testing: Testing agency shall survey entire roof area for entrapped water within roof assembly according to ASTM D7954/D7954M.
    - a. Perform tests before overlying construction is placed.
    - b. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.
      - 1) Cost of retesting is Contractor's responsibility.
    - c. Testing agency shall prepare survey report indicating locations of entrapped moisture, if any.
  3. Low-Voltage Electrical Conductance Testing: Testing agency shall survey entire roof area and flashings to locate discontinuity in the roof membrane using an exposed metal electrical loop to create an electrical field tested with handheld probes.
    - a. Perform tests before overlying construction is placed.
    - b. After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.
      - 1) Cost of retesting is Contractor's responsibility.
    - c. Testing agency shall prepare survey report indicating locations of initial discontinuities, if any.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

**3.10 PROTECTING AND CLEANING**

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**3.11 ROOFING INSTALLER'S WARRANTY**

- A. WHEREAS \_\_\_\_\_ of \_\_\_\_\_, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
  - 1. Owner: **<Insert name of Owner>**.
  - 2. Address: **<Insert address>**.
  - 3. Building Name/Type: **<Insert information>**.
  - 4. Address: **<Insert address>**.
  - 5. Area of Work: **<Insert information>**.
  - 6. Acceptance Date: \_\_\_\_\_.
  - 7. Warranty Period: **<Insert time>**.
  - 8. Expiration Date: \_\_\_\_\_.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
  - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
    - a. lightning;
    - b. fire;
    - c. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    - d. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    - e. vapor condensation on bottom of roofing; and
    - f. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
  - 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.

- 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
- 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
- 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
- 6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
- 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this \_\_\_\_\_ day of \_\_\_\_\_, \_\_\_\_\_.

- 1. Authorized Signature: \_\_\_\_\_.
- 2. Name: \_\_\_\_\_.
- 3. Title: \_\_\_\_\_.

END OF SECTION 075423

## **SECTION 076200 - SHEET METAL FLASHING AND TRIM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Manufactured reglets with counterflashing.
  2. Formed low-slope roof sheet metal fabrications.
  3. Formed wall sheet metal fabrications.
  4. Formed equipment support flashing.
  5. Formed overhead-piping safety pans.
- B. Related Requirements:
  1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
  2. Section 042000 "Unit Masonry" for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry.

#### **1.3 COORDINATION**

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
  3. Review requirements for insurance and certificates if applicable.
  4. Review sheet metal flashing observation and repair procedures after flashing installation.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each of the following
  1. Underlayment materials.
  2. Elastomeric sealant.
  3. Butyl sealant.
  4. Epoxy seam sealer.
- B. Shop Drawings: For sheet metal flashing and trim.
  1. Include plans, elevations, sections, and attachment details.
  2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
  3. Include identification of material, thickness, weight, and finish for each item and location in Project.

4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of roof-penetration flashing.
8. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
9. Include details of special conditions.
10. Include details of connections to adjoining work.
11. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For fabricator.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

#### **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

#### **1.8 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
  1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

#### **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

#### **1.10 WARRANTY**

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Finish Warranty Period: **10** years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- A. FM Approvals Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### **2.2 SHEET METALS**

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
  - 1. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Color: To be selected by Architect from Manufacturer's full range.
  - 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation; prepainted by coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Surface: Smooth, flat.
  - 2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 3. Color: To be selected by Architect from Manufacturer's full range.
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

- C. Stainless Steel Sheet: ASTM A240/A240M, Type 316, dead soft, fully annealed; with smooth surface.
  - 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled) or ASTM A480/A480M, No. 3 (coarse, polished directional satin).
    - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- D. Zinc Sheet: Zinc, 99 percent pure, alloyed with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum; with manufacturer's standard factory-applied, flexible, protective back coating.
  - 1. Source Limitations: Obtain sheet from single source from single manufacturer.
  - 2. Finish: Bright rolled.

### 2.3 UNDERLAYMENT MATERIALS

- A. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Carlisle SynTec
  - 2. Firestone
  - 3. GAF
  - 4. Johns Manville
- C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

### 2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- A. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- B. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

- C. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.
- E. Solder:
  - 1. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
  - 2. For Zinc: ASTM B32, 40 percent tin and 60 percent lead with low antimony, with maximum lead content of 0.2 percent, as recommended by zinc manufacturer.

## 2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
  - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
  - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
  - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams:
  - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  - 2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
  - 3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.



- H. Do not use graphite pencils to mark metal surfaces.

## **2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS**

- A. Copings: Fabricate in minimum 96-inch-long, but not exceeding 12-foot-long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Formed corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
  - 1. Coping Profile: As shown in the drawings and per to SMACNA's "Architectural Sheet Metal Manual."
  - 2. Joint Style: Butted with expansion space and 6-inch-wide, concealed backup plate unless otherwise noted.
  - 3. Fabricate from the Following Materials:
    - a. Aluminum: 0.050 inch thick.
    - b. Zinc: where noted, 0.059 inch (1.50 mm) thick. Similar to metal panels MT-01 as specified in 074213 "Metal Wall and Soffit Panels".
- B. Roof and Roof-to-Wall Transition and Fascia-Cap Transition Expansion-Joint Cover: Fabricate from the following materials: Shop fabricate interior and exterior corners.
  - 1. Aluminum: 0.050 inch thick.
- C. Counterflashing and Flashing Receivers: Shop fabricate interior and exterior corners. Fabricate from the following materials:
  - 1. Aluminum: 0.032 inch thick.
- D. Roof-Penetration Flashing: Fabricate from the following materials:
  - 1. Galvanized Steel: 0.028 inch thick.
- E. Roof-Drain Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.016 inch thick.

## **2.7 WALL SHEET METAL FABRICATIONS**

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:
  - 1. Stainless Steel: 0.016 inch thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
  - 1. Aluminum: 0.032 inch thick.

## **2.8 MISCELLANEOUS SHEET METAL FABRICATIONS**

- A. Equipment Support Flashing: Fabricate from the following materials:
  - 1. Stainless Steel: 0.019 inch thick.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.

2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF UNDERLAYMENT

- A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
- B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.
- C. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

### 3.3 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
  4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
  5. Torch cutting of sheet metal flashing and trim is not permitted.
  6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
  2. Use lapped expansion joints only where indicated on Drawings.

- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 3/4 inch for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
  - 1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
  - 1. Do not solder aluminum sheet.
  - 2. Do not use torches for soldering.
  - 3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
  - 4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

### 3.4 INSTALLATION OF ROOF FLASHINGS

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- D. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
  - 1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
  - 2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
- E. Copings: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

- F. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- G. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of interlocking folded seam or blind rivets and sealant unless otherwise indicated.
- H. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

### **3.5 INSTALLATION OF WALL FLASHINGS**

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

### **3.6 INSTALLATION OF MISCELLANEOUS FLASHING**

- A. Equipment Support Flashing:
  - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  - 2. Weld or seal flashing with elastomeric sealant to equipment support member.

### **3.7 INSTALLATION TOLERANCES**

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### **3.8 CLEANING**

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### **3.9 PROTECTION**

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

## **SECTION 077123 - MANUFACTURED GUTTERS AND DOWNSPOUTS**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Furnish and install premanufactured water control components per the drawings and specifications, including all clips, sealant, fasteners, and joining to make weathertight and watertight. Components and accessories shall be factory-fabricated and supplied by a specified Manufacturer.
- B. Components specified in this section include but are not limited to Wind Resistant Gutters, Downspouts and Scuppers and Conductor Heads.
- C. Contractor shall utilize Manufacturer's technical representative to perform field measuring, takeoff, shop drawing development and order processing for all gutter components specified in this section.

#### **1.2 RELATED REQUIREMENTS**

- A. Section 075423 Thermoplastic-polyolefin (TPO) Roofing
- B. Section 079200 – Joint Sealants: Non-curing sealants.

#### **1.3 REFERENCE STANDARDS**

- A. FM Global ([www.fmglobal.com](http://www.fmglobal.com)).
- B. SPRI (Single Ply Roofing Industry) ([www.spri.org](http://www.spri.org)):
  - 1. ANSI/SPRI GT-1 – Test Standard for Gutter Systems.

#### **1.4 SUBMITTALS**

- A. Comply with Division 01.
- B. Gutters shall be manufactured in specified manufacturer's facilities. Gutters fabricated by installer or other fabricator will not be acceptable unless fabricator can demonstrate to Architect's satisfaction that Gutters have been tested for resistance in accordance with Test Method G-1 and G-2 of SPRI GT-1.
- C. Product Data: Submit manufacturer's product data, including installation instructions.
- D. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, and details, indicating dimensions, materials, components, fasteners, finish, and accessories.
- E. Samples: Submit manufacturer's sample of gutters.
  - 1. Sample Size: Minimum 5.5" long.

- F. Color Samples: Submit manufacturer's color samples of gutters, consisting of complete set of metal color chips representing manufacturer's full range of available colors.
- G. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- H. Warranty Documentation: Submit manufacturer's standard warranty.

## **1.5 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in the manufacturing of gutters of similar type to that specified for a minimum of 5 years.
- B. Installer's Qualifications:
  - 1. Installer regularly engaged in installation of gutters of similar type to that specified for a minimum of 5 years.
  - 2. Use persons trained for installation of gutters.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage and Handling Requirements:
  - 1. Store and handle materials in accordance with manufacturer's instructions.
  - 2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
  - 3. Store materials in clean, dry area indoors.
  - 4. Do not store materials directly on floor or ground.
  - 5. Protect materials and finish during storage, handling, and installation to prevent damage.

## **1.7 WARRANTY**

- A. Wind Warranty Period: Warranted in wind conditions up to 160 mph with a 30 Year wind warranty. Warranty specified for individual products below. (Gutter Only)
- B. Warranty Period, Product: 5-year workmanship warranty covering replacement or repair of products that are defective in material or workmanship. (All Products)
- C. Warranty Period, Finish: Limited 30-year warranty for prefinished coil-coated steel and aluminum coated with Kynar 500 standard colors covering fade, chalk, and film integrity.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design Manufacturer: Metal-Era, LLC, 1600 Airport Road, Waukesha, Wisconsin 53188. Phone 800-558-2162. [www.metalera.com](http://www.metalera.com). [info@metalera.com](mailto:info@metalera.com).
- B. Acceptable Manufacturers:
  - 1. ATAS International, Inc.

2. Dimensional Metals, Inc. (DMI)
- C. Single Source: Provide materials from single manufacturer.

## 2.2 GUTTERS

- A. Gutter:
1. Profile: Box
  2. Approvals:
    - a. ANSI/SPRI GT-1-24 ga./0.040" - 136 psf vertical and 223 psf horizontal, for 22 ga./0.050"/0.063" - 108 psf vertical and 223 psf horizontal.
    - b. FM Approved 1-90 system rating.
  3. Gutter Size:
    - a. Indicated on the Drawings.
  4. Material: 24-gauge (0.65-mm) galvanized steel.
  5. Formed Lengths: 12'-0".
  6. Fastener Holes: Pre-punched holes.
  7. Concealed Splice Plates
    - a. Material: Same as gutters.
    - b. Finish and Color: Same as gutters.
    - c. Width: 6".
  8. Finish: Prefinished Kynar.
  9. Color: As Indicated on Drawings.
- B. Factory-Fabricated Accessories: Quicklock.
1. Miters.
  2. End caps.
  3. Expansion joints.
  4. Special corners.
  5. Material, Finish, and Color: Same as gutters.
- C. Fasteners:
1. Suitable for intended substrate.
  2. Provided by gutter manufacturer.

## 2.3 DOWNSPOUTS

- A. Downspouts: Industrial Downspout-Closed.
1. Material: 24-gauge (0.65-mm) galvanized steel.
  2. Formed Lengths: 12'-0".
  3. Seams: Double Seam Lock.
  4. Attachment Straps: Style 1.
    - a. Width: 2".
    - b. Straps per 12-Foot Downspout Length: 3.
  5. Standard Elbows: Style A.
    - a. Material: Match downspouts.
    - b. Finish: Match downspouts.
    - c. Color: Match downspouts.
  6. Offset Elbows: Eave condition.
    - a. Material: 0.050" aluminum.
    - b. Finish: Match downspouts.
    - c. Color: Match downspouts.



7. Outlets: 0.040" aluminum.
8. Downspout Transitions:
  - a. Material: Match downspouts.
  - b. Finish: Match downspouts.
  - c. Color: Match downspouts.
  - d. Seams: Quicklock.

## **2.4 SCUPPERS AND CONDUCTOR HEADS**

- A. Thru-Wall Scuppers: Pop-riveted, raised conductor head, style 1.
  1. Material: 24 ga. galvanized steel.
  2. Picture Frames: Front, 2" wide; back, 3" wide.
- B. Conductor Heads: Pop-riveted, style 1.
  1. Material: 24 ga. galvanized steel.
  2. Flange: Fasten to wall, 2" wide.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive gutters.
- B. Verify surfaces to support gutters are clean, dry, secure, and of proper dimensions.
- C. Verify roof edge is level and wood nailers are straight.
- D. Notify Architect of conditions that would adversely affect installation.
- E. Do not begin installation until unacceptable conditions are corrected.

### **3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Install products to allow water to drain from edge of roof.
- C. Install products to allow for thermal movement.
- D. Joint Sealants: Apply joint sealants in accordance with manufacturer's instructions.
- E. Review lengths of straight pieces before cutting to avoid creating relatively short sections adjacent to full-length sections.
- F. Isolate products from ACQ treated wood blocking or other galvanically incompatible material with appropriate membrane material.

**3.3 CLEANING**

- A. Clean products promptly after installation in accordance with manufacturer's instructions.
- B. Remove clear protective vinyl film.
- C. Do not use harsh cleaning materials or methods that could damage finish.

**3.4 PROTECTION**

- A. Protect installed products to ensure that, except for normal weathering, products will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 077123

## **SECTION 077200 - ROOF ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Roof hatches.
- B. Related Requirements:
  - 1. Section 055000 "Metal Fabrications" for metal vertical ladders for access to roof hatches.
  - 2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
  - 3. Division 23 for standard curbs provided with equipment.

#### **1.3 COORDINATION**

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of roof accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
  - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of roof accessories specified in this Section.
  - 2. Method of attaching roof accessories to roof or building structure.
  - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
  - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

**PART 2 - PRODUCTS****2.1 ROOF HATCHES**

- A. Manufacturer:
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. BILCO Company
  2. Acceptable Manufacturers:
    - a. Babcock-Davis
    - b. Elmdor Manufacturing Co.
- B. Furnish and install where indicated on plans metal roof hatch, size width: 30" x length: 54". Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
- C. Performance characteristics:
1. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
  2. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span or 20 psf wind uplift.
  3. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  4. Operation of the cover shall not be affected by temperature.
  5. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- D. Cover: Shall be 11-gauge aluminum with a 5" beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- E. Cover insulation: Shall be 3" thick polyisocyanurate with an R-value = 20.3, fully covered and protected by an 18-gauge aluminum liner.
- F. Curb: Shall be 12" in height and of 11-gauge aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. The curb shall be formed with a 5-1/2" flange with 7/16" holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, including stamped tabs, 6" on center, to be bent inward to hold single ply roofing membrane securely in place.
- G. Curb insulation: Shall be 3" thick polyisocyanurate with an R-value = 20.3.
- H. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
- I. Hardware
1. Heavy stainless steel pintle hinges shall be provided
  2. Cover shall be equipped with a spring latch with interior and exterior turn handles

3. Roof hatch shall be equipped with interior and exterior padlock hasps.
4. The latch strike shall be a stamped component bolted to the curb assembly.
5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" diameter red vinyl grip handle to permit easy release for closing.
6. All hardware shall be zinc plated and chromate sealed. For installation in highly corrosive environments or when prolonged exposure to hot water or steam is anticipated, specify Type 316 stainless steel hardware.
7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
8. Provide safety post per manufacturer.

J. Finishes: Factory finish shall be mill finish aluminum.

## 2.2 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation and mill phosphatized for field painting where indicated.
1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
  2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
  3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  4. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
  5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
  2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
  4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

- C. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
  - 1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
  - 2. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  - 3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- D. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
- E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- F. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- G. Steel Tube: ASTM A 500, round tube.
- H. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- I. Steel Pipe: ASTM A 53/A 53M, galvanized.

### 2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.
- C. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.
- D. Polyisocyanurate Board Insulation: ASTM C 1289, thickness as indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWWA C2; not less than 1-1/2 inches thick.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Underlayment:
  - 1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
  - 2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
  - 3. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.
- H. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
  - 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
  4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- I. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
  - J. Elastomeric Sealant: ASTM C 920, elastomeric **silicone** polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
  - K. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
  - L. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
  1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  1. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
  3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- A. Roof Hatch: Install products in strict accordance with manufacturer's instructions and approved submittals. Locate units level, plumb, and in proper alignment with adjacent work.
1. Test units for proper function and adjust until proper operation is achieved.
  2. Repair finishes damaged during installation.
  3. Restore finishes so no evidence remains of corrective work.
- C. Seal joints with butyl sealant as required by roof accessory manufacturer.

### **3.3 REPAIR AND CLEANING**

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Clean exposed surfaces according to manufacturer's written instructions.
- C. Clean off excess sealants.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200



## **SECTION 079200 - JOINT SEALANTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Silicone joint sealants.
  2. Urethane joint sealants.
  3. Butyl joint sealants.
  4. Elastomeric Polyurethane sealants.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each joint-sealant product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Joint-Sealant Schedule: Include the following information:
  1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
  1. Joint-sealant location and designation.
  2. Manufacturer and product name.
  3. Type of substrate material.
  4. Proposed test.
  5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
  1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion-Test Reports: For each sealant application tested.
- G. Sample Warranties: For special warranties.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
  - 1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

## 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - 1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - 2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
  - 3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
  - 4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
  - 5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - 6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
  - 7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
  - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  - 2. Conduct field tests for each kind of sealant and joint substrate.
  - 3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  - 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - 5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.

6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## **1.8 FIELD CONDITIONS**

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## **1.9 WARRANTY**

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  2. Disintegration of joint substrates from causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## **PART 2 - PRODUCTS**

### **2.1 JOINT SEALANTS, GENERAL**

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### **2.2 NONSTAINING SILICONE JOINT SEALANTS**

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  1. Manufacturers:

- a. Basis of design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - 1) Dow Corning
- b. Acceptable Manufacturers:
  - 1) Pecora Corporation
  - 2) Tremco Incorporated
  - 3) Chemlink, Durasil

### 2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT.
  - 1. Manufacturers:
    - a. Basis of design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Dow Corning
    - b. Acceptable Manufacturers:
      - 1) Pecora Corporation
      - 2) Tremco Incorporated
- B. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Uses T and NT.
  - 1. Manufacturers:
    - a. Basis of design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Dow Corning
    - b. Acceptable Manufacturers:
      - 1) Pecora Corporation
      - 2) Tremco Incorporated
      - 3) Chemlink, Durasil

### 2.4 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

### 2.5 ELASTOMERIC POLYURETHANE SEALANTS

- A. Polyurethane-based, non-sag elastomeric sealant: ASTM C920, Type S, Grade NS, Class 100/50, Use T, NT, G, A, O, M.
  - 1. Manufacturers:
    - a. Basis of design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Sika
    - b. Acceptable Manufacturers:
      - 1) Dow Corning
      - 2) Tremco Incorporated

## **2.6 JOINT-SEALANT BACKING**

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Joint Filler Board: Closed cell, chemical resistant, thermally stable, bitumen or bitumen-free, pre-moulded compressible joint filler board

## **2.7 MISCELLANEOUS MATERIALS**

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
    - c. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

- a. Metal.
  - b. Glass.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of sealant backings.
  2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
  4. Provide flush joint profile according to Figure 8B in ASTM C1193 unless otherwise noted.

### 3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
1. Extent of Testing: Test completed and cured sealant joints as follows:
    - a. Perform 5 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
    - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  3. Inspect tested joints and report on the following:
    - a. Whether sealants filled joint cavities and are free of voids.
    - b. Whether sealant dimensions and configurations comply with specified requirements.
    - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
  4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
  5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### **3.5 CLEANING**

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### **3.6 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### **3.7 JOINT-SEALANT SCHEDULE**

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
  1. Joint Locations:
    - a. Isolation and contraction joints in cast-in-place concrete slabs.
    - b. Joints between different materials listed above.
    - c. Other joints as indicated on Drawings.
  2. Joint Sealant: Urethane, M, P, 50, T, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Joints between plant-precast architectural concrete units.
    - c. Joints between metal panels.
    - d. Joints between different materials listed above.
    - e. Perimeter joints between materials listed above and frames of doors and louvers.
    - f. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT>.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 1. Joint Locations:
    - a. Control and expansion joints on exposed interior surfaces of exterior walls.
    - b. Vertical joints on exposed surfaces of concrete.
    - c. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Urethane, S, NS, 50, NT.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200



**SECTION 081113 - HOLLOW METAL DOORS AND FRAMES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes:
  - 1. Interior standard steel doors and frames.
  - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
  - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

**1.3 DEFINITIONS**

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

**1.4 COORDINATION**

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

**1.5 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of each different wall opening condition.
  - 6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 7. Details of anchorages, joints, field splices, and connections.
  - 8. Details of accessories.
  - 9. Details of moldings, removable stops, and glazing.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

**1.7 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.
- B. Field quality control reports.

**1.8 CLOSEOUT SUBMITTALS**

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

**1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
  - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers:
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approve by Architect prior to bid:
    - a. Ceco
  - 2. Acceptable Manufacturers:
    - a. Curries Company
    - b. Custom Metal
    - c. Steelcraft

**2.2 PERFORMANCE REQUIREMENTS**

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. when tested according to ASTM C518.

**2.3 INTERIOR STEEL DOORS AND FRAMES**

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- A. Commercial Doors and Frames: NAAMM-HMMA 861.
  - 1. Physical Performance: Level A according to SDI A250.4.
  - 2. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches
- c. Face: Metallic-coated, cold-rolled steel sheet, minimum thickness of 0.042 inch.
- d. Edge Construction: Continuously welded with no visible seam.
- e. Core: Steel stiffened.
- 3. Frames:
  - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch for door openings 48 inches or less, or window frames; minimum thickness of 0.067 inch for door openings greater than 48 inches.
  - b. Construction: Full profile welded.
- 4. Exposed Finish: Prime.

## 2.4 EXTERIOR STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B.
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.
    - c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A40 (ZF120) coating.
    - d. Edge Construction: Model 2, Seamless.
    - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
    - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
    - h. Core: Polyurethane or Polyisocyanurate.
      - 1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than R13 when tested according to ASTM C 1363.
  - 2. Frames:
    - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A40 (ZF120)] coating.
    - b. Construction: Full profile welded.
  - 3. Exposed Finish: Prime.

## 2.5 BORROWED LITES

- A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch.
- B. Construction: Full profile welded.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

## 2.6 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
  - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
  - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
  - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

## 2.7 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
  - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- I. Glazing: Comply with requirements in Section 088000 "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

## 2.8 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
  2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
  4. Terminated Stops: Terminate stops 6 inches above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
  2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
  4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
  5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

## 2.9 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### 3.2 INSTALLATION

- A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- A. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
  - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    - a. At fire-rated openings, install frames according to NFPA 80.
    - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    - c. Install frames with removable stops located on secure side of opening.
    - d. Install door silencers in frames before grouting.
    - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    - g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
  - 2. Fire-Rated Openings: Install frames according to NFPA 80.
  - 3. Floor Anchors: Secure with postinstalled expansion anchors.
    - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
  - 4. Solidly pack mineral-fiber insulation inside frames.
  - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
  - 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  - 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
  - 1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8 or NAAMM-HMMA 841 and NAAMM-HMMA guide specification indicated.
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

### 3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

**SECTION 081416 - FLUSH WOOD DOORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Five-ply flush wood veneer-faced doors for transparent finish.
- B. Related Requirements:
  - 1. Section 088000 "Glazing" for glass view panels in flush wood doors.

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product, including the following:
  - 1. Door core materials and construction.
  - 2. Door edge construction
  - 3. Door face type and characteristics.
  - 4. Door trim for openings.
  - 5. Door frame construction.
  - 6. Factory-machining criteria, finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
  - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
  - 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
  - 3. Details of frame for each frame type, including dimensions and profile.
  - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 5. Dimensions and locations of blocking for hardware attachment.
  - 6. Dimensions and locations of mortises and holes for hardware.
  - 7. Clearances and undercuts.
  - 8. Requirements for veneer matching.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
  - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For special warranty.

**1.6 CLOSEOUT SUBMITTALS**

- A. Special warranties.
- B. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.



**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

**1.8 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
- B. Environmental Limitations: Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

**1.9 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Delamination of veneer.
    - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
    - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
  - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
  - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Source Limitations: Obtain flush wood doors from single manufacturer.
- B. Manufacturers (**ST-1**)
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approve by Architect prior to bid:
    - a. VT Industries
      - 1) Species: White Birch
      - 2) Color: Ravine RA07
  - 2. Acceptable Manufacturers:
    - 1) Chappell Door
    - 2) Eggers Industries
    - 3) Graham Wood Doors
    - 4) Marshfield Door Systems
    - 5) Mohawk Flush Doors
    - 6) Algoma Hardwoods

**2.2 PERFORMANCE REQUIREMENTS**

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-

protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252.

### 2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards."
  - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.
- B. Adhesives: Do not use adhesives that contain urea formaldehyde
- C. WDMA I.S.1-A Performance Grade:
  - 1. Heavy Duty unless otherwise indicated.
- D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252.
  - 1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
  - 2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
  - 3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
  - 4. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

### 2.4 FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors:
  - 1. Performance Grade: WDMA I.S. 1A Heavy Duty unless otherwise indicated.
  - 2. WDMA I.S. 1A Grade: Premium.
  - 3. Faces: Single-ply wood veneer not less than 1/50 inch thick.
    - a. Species: White birch.
    - b. Cut: Plain sliced (flat sliced).
    - c. Match between Veneer Leaves: Book match.
    - d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
    - e. Pair and Set Match: Provide for doors hung in same opening.
    - f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
  - 4. Exposed Vertical and Top Edges: Same species as faces - Architectural Woodwork Standards edge Type A.
    - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
    - b. Fire-Rated Pairs of Doors: Provide formed-steel edges and astragals with intumescent seals.
      - 1) Finish steel edges and astragals with baked enamel same color as doors.
    - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
      - 1) Screw-Holding Capability: 475 lbf in accordance with WDMA T.M. 10.

5. Core for Non-Fire-Rated Doors: ANSI A208.1, Grade LD-1 particleboard.
  - a. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
    - 1) 5-inch top-rail blocking, in doors indicated to have closers.
    - 2) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
    - 3) 5-inch midrail blocking, in doors indicated to have exit devices.
  - b. Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."
6. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
  - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
    - 1) 5-inch top-rail blocking.
    - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
    - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
    - 4) 5-inch midrail blocking, in doors indicated to have exit devices.
7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

## 2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
  1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
  2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
  1. Locate hardware to comply with DHI-WDHS-3.
  2. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
  3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
  4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
  5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
  1. Light Openings: Trim openings with moldings of material and profile indicated.
  2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

## 2.6 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
  1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  2. Finish faces, all four edges, edges of cutouts, and mortises.
  3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:

1. Grade: Premium.
2. Finish: Architectural Woodwork Standards System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Filled finish.
5. Sheen: Satin.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
  1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Hardware: For installation, see Section 087100 "Door Hardware".
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
  1. Install fire-rated doors and frames in accordance with NFPA 80.
- C. Job-Fitted Doors:
  1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
  2. Machine doors for hardware.
  3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  4. Clearances:
    - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
    - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
    - d. Comply with NFPA 80 for fire-rated doors.
  5. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
  6. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

#### **3.3 ADJUSTING**

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

**SECTION 083613 - SECTIONAL DOORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Insulated sectional-door assemblies.
  - 2. Electric operators and controls.
- B. Related Requirements:
  - 1. Section 034713 "Tilt-Up Concrete" for prepared opening in concrete. Execution requirements for placement of anchors in concrete wall construction.
  - 2. Section 055000 "Metal Fabrications" for miscellaneous steel supports.
  - 3. Section 099123 for finish painting of factory-primed steel doors.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type and size of sectional door and accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
  - 2. For power-operated doors, include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
  - 4. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- D. Samples for Initial Selection: For units with factory-applied finishes.
  - 1. Include Samples of accessories involving color selection.

- E. Samples for Verification: For each type of exposed finish and for each color and texture required on the following components, in manufacturer's standard sizes:
  - 1. Glazing.
  - 2. Metal for door sections.
  - 3. Hardware.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Sample Warranties: For manufacturer's warranty and finish warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For sectional doors to include in maintenance manuals.
- B. Manufacturer's warranty.
- C. Finish warranty.

#### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
- B. Regulatory Requirements: Comply with provisions in the U.S. Department of Justice's "2010 ADA Standards for Accessible Design", ICC A117.1 applicable to sectional doors.

#### **1.7 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Failure of components or operators before reaching required number of operation cycles.
    - c. Faulty operation of hardware.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
    - e. Delamination of exterior or interior facing materials.
  - 2. Warranty Period: 5 years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  1. Overhead Door Corp.
- B. Acceptable Manufacturers:
  1. Wayne Dalton
  2. Clopay Garage Doors
  3. Raynor Garage Doors
- C. Source Limitations: Obtain sectional doors from single source from single manufacturer.
  1. Obtain operators and controls from sectional door manufacturer.

### **2.2 INSULATED SECTIONAL OVERHEAD DOORS**

- A. Insulated Steel Sectional Overhead Doors: Units shall have the following characteristics:
  1. Door Assembly: Metal/foam/metal sandwich panel construction, with PVC thermal break and weather-tight ship-lap design meeting joints.
    - a. Panel Thickness: 1-5/8 inches (41 mm).
    - b. Exterior Surface: Ribbed, textured.
    - c. Exterior Steel: .015 inch (.38 mm), hot-dipped galvanized.
    - d. End Stiles: 16 gauge.
    - e. Spring Counterbalance: Sized to weight of the door, with a helically wound, oil tempered torsion spring mounted on a steel shaft; cable drum of diecast aluminum with high strength galvanized aircraft cable. Sized with a minimum 7 to 1 safety factor.
      - 1) High cycle spring: 25,000 cycles.
    - f. Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.
    - g. Thermal Values: R-value of 14.86; U-value of 0.067.
    - h. Air Infiltration: 0.08 cfm at 15 mph; 0.08 cfm at 25 mph.
    - i. Partial Glazing of Steel Panels:
      - 1) 1/4 inch (6 mm) Tempered glass.
  2. Finish and Color:
    - a. Two coat baked-on polyester:
      - 1) White.
  3. Windload Design: Provide to meet the Design/Performance requirements specified.
  4. Hardware: Galvanized steel hinges and fixtures. Ball bearing rollers with hardened steel races.
  5. Lock:
    - a. Interior mounted slide lock with interlock switch for automatic operator.
  6. Weatherstripping:
    - a. EPDM bulb-type strip at bottom section.
    - b. Flexible Jamb seals.

- c. Flexible Header seal.
- 7. PTrack: Provide track as recommended by manufacturer to suit loading required and clearances available.
  - a. Size:
    - 1) 2 inch (51 mm).
    - 2) 3 inch (76 mm).
  - b. Type:
    - 1) High lift.
- 8. Electric Motor Operation: Provide UL listed electric operator, size and type as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second. Operator shall meet UL325/2010 requirements for continuous monitoring of safety devices. Operator shall be wall mounted.
  - a. Entrapment Protection: Required for momentary contact, includes radio control operation.
    - 1) Photoelectric sensors monitored to meet UL 325/2010.
  - b. Operator Controls:
    - 1) Push-button operated control stations with open, close, and stop buttons.
    - 2) Surface mounting.
    - 3) Interior location.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Do not begin installation until openings have been properly prepared.
- B. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.
- C. Verify electric power is available and of correct characteristics.
- D. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### **3.3 INSTALLATION**

- A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.
- B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.



- C. Anchor assembly to wall construction and building framing without distortion or stress.
- D. Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- E. Fit and align door assembly including hardware.
- F. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

### **3.4 CLEANING AND ADJUSTING**

- A. Adjust door assembly to smooth operation and in full contact with weatherstripping.
- B. Clean doors, frames and glass.
- C. Remove temporary labels and visible markings.

### **3.5 PROTECTION**

- A. Do not permit construction traffic through overhead door openings after adjustment and cleaning.
- B. Protect installed products until completion of project.
- C. Touch-up, damaged coatings and finishes and repair minor damage before Substantial Completion.

END OF SECTION 083613

## **SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Exterior and interior storefront framing.
  2. Storefront framing for punched openings.
  3. Exterior and interior manual-swing entrance doors.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
  1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
  1. Joinery, including concealed welds.
  2. Anchorage.
  3. Expansion provisions.
  4. Glazing.
  5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### **1.5 INFORMATIONAL SUBMITTALS**

- A. Preconstruction Laboratory Mockup Testing Submittals:
  - 1. Testing Program: Developed specifically for Project.
  - 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
  - 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- B. Qualification Data: For Installer.
- C. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
  - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront. The label certificate shall be project specific and will contain the thermal performance ratings of the manufacturer's framing combined with the specified glass, and the glass spacer used in the fabrication of the glass, at NFRC standard test size as defined in table 4-3 in NFRC 100-2010.
- D. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Sample Warranties: For special warranties.

### **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

### **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- C. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems.
- D. An NFRC Component Modeling Approach (CMA) generated label certificate shall be provided by the manufacturer. The label certificate shall be project specific and will contain the thermal performance ratings of the manufacturer's framing combined with the specified glass, and the glass spacer used in the fabrication of the glass, at NFRC standard test size as defined in table 403 in NFRC 100-2010.

## 1.8 WARRANTY

- A. Total Storefront Installation
  - 1. The responsible contractor shall assume full responsibility and warrant for one year the satisfactory performance of the total storefront installation. This includes the glass (including insulated units), glazing, anchorage and setting system, sealing, flashing, etc., as it relates to air, water and structural adequacy as called for in the specifications and approved shop drawings.
  - 2. Any deficiencies due to such elements not meeting the specifications shall be corrected by the responsible contractor at their expense during the warranty period.
- B. Special Warranty: Manufacturer and Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    - d. Water penetration through fixed glazing and framing areas.
    - e. Failure of operating components.
  - 2. Warranty Period: **10** years from date of Substantial Completion.
- C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: **10** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.

- e. Failure of operating units.
- C. Deflection of Framing Members: In accordance with ASTM E330, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
  3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
    - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- D. Structural: Test according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures at minimum 20.0psf, assemblies do not evidence deflection exceeding specified limits.
  2. When tested at **150** percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **0.2** percent of span.
  3. Test Durations: As required by design wind velocity, but not less than **10** seconds.
- E. Air Infiltration: Test according to ASTM E 283 at a static air pressure difference of 6.24psf for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.06 cfm/sq. ft at a static-air-pressure differential of 6.24 lbf/sq. ft.
  2. Entrance Doors:
    - a. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- F. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.
- G. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.
  2. Maximum Water Leakage: According to AAMA 501.1 Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor):
    - a. Conductive thermal transmittance (U-Factor) shall not be more than 0.37 BTU/hr.sq.ft.F when glazed with 0.24 center of glass U-Factor.
  2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
  3. Condensation Resistance (CRF):
    - a. Test unit in accordance with AAMA 1503.1
    - b. Condensation Resistance Factor (CRF) shall not be less than 67 (frame) when glazed with 0.24 center of glass U-Factor.

- I. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows.
  - 1. Outdoor-Indoor Transmission Class: Minimum 34.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
  - 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
    - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
    - b. Low Exterior Ambient-Air Temperature: 0 deg F.
    - c. Interior Ambient-Air Temperature: 75 deg F.
- K. Project Wind Loads
  - 1. As delegated design, engineer of curtain wall system is responsible for final loads applicable to building and climactic zone.
  - 2. The system shall be designed to withstand the following loads normal to the plane of the wall:
    - a. Positive pressure of 25psf at non-corner zones.
    - b. Negative pressure of 25psf at non-corner zones.
    - c. Negative pressure of 30psf at corner zones.
- L. Structural-Sealant Joints:
  - 1. Designed to carry gravity loads of glazing.
  - 2. Designed to produce tensile or shear stress of less than 20 psi.
- M. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed storefront system without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
  - 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

### 2.3 STOREFRONT SYSTEMS

- A. Basis of Design: Glass product selections are based upon the primary glass manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - 1. Kawneer Trifab VersaGlaze 451T Framing System.
    - a. 2" x 4-1/2" nominal dimension.
    - b. Thermal.
    - c. Center glazed.
    - d. Screw spline.
- B. Acceptable Manufacturers:
  - 1. EFCO, Series 433 Thermal Screw Spline Storefront
  - 2. Traco
  - 3. Tubelite, TU24000
  - 4. YKK, 45TU
  - 5. Oldcastle Building Envelope 3000T

- C. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer. Single manufacturer requirement shall include products specified in 084113 Glazed Aluminum Curtain Walls.

## 2.4 MATERIALS

- A. Aluminum Extrusions:
  - 1. Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish.
  - 2. Not less than 0.070" (1.8 mm) wall thickness at any location for the main frame.
  - 3. Complying with ASTM B221: 6063-T6 alloy and temper.
- B. Fasteners:
  - 1. Aluminum, nonmagnetic stainless steel or other materials must be non-corrosive and compatible with aluminum members, trim hardware, anchors, and other components.
- C. Anchors, Clips and Accessories:
  - 1. Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating.
  - 2. Anchors, clips, and accessories shall provide sufficient strength to withstand the design pressure indicated.
- D. Reinforcing Members:
  - 1. Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating.
  - 2. Reinforcing members must provide sufficient strength to withstand the design pressure indicated
- E. Sealant:
  - 1. For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.
- F. Tolerances:
  - 1. References to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

## 2.5 STOREFRONT FRAMING SYSTEM

- A. Thermal Barrier:
  - 1. Thermal Break with dual nominal 1/4" (6.4 mm) separation consisting of a two-part chemically curing, high-density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections.
  - 2. Thermal break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.
- B. Brackets and Reinforcements:
  - 1. Manufacturer's standard high-strength aluminum with non-staining, non-ferrous shims for aligning system components.

- C. Fasteners and Accessories:
  1. Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories must be compatible with adjacent materials.
  2. Where exposed, fasteners and accessories shall be stainless steel.
- D. Perimeter Anchors:
  1. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
- E. Packing, Shipping, Handling, and Unloading:
  1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- F. Storage and Protection:
  1. Store materials so that they are protected from exposure to harmful weather conditions.
  2. Handle material and components to avoid damage.
  3. Protect material against damage from elements, construction activities, and other hazards before, during, and after installation.

## 2.6 GLAZING SYSTEMS

- A. Glazing to meet requirements in Division 08 Glazing Section.
- B. Glazing Gaskets:
  1. Manufacturer's standard compression types
  2. Replaceable, extruded EPDM rubber
- C. Spacers and Setting Blocks:
  1. Manufacturer's standard elastomeric type
- D. Bond-Breaker Tape:
  1. Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- E. Glazing Sealants for structural-sealant-glazed systems as recommended by manufacturer for joint type, and as follows:
  1. Structural Sealant:
    - a. ASTM C 1184
    - b. Single-component neutral-curing silicone formulation that is compatible with the system components with which it comes in contact
    - c. Specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in the aluminum-framed systems indicated
    - d. Color: Black
  2. Weatherseal sealant:
    - a. ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O



- b. Single-component neutral-curing formulation that is compatible with the structural sealant and other system components with which it comes in contact
- c. Recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use
- d. Color: Matching structural sealant

## 2.5 ENTRANCE DOOR SYSTEMS

- A. Basis of Design: Glass product selections are based upon the primary glass manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - 1. Kawneer 260/360/560 Insulclad Thermal Entrances
- B. Acceptable Manufacturers:
  - 1. EFCO Thermastile Desires D502
  - 2. YYK 25T/35T/50T Thermally Broken Entrance System
- C. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
  - 1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
    - a. Thermal Construction for exterior doors: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
  - 2. Door Design: 5" Wide stile unless otherwise indicated.
  - 3. Glazing Stops and Gaskets: **Beveled**, snap-on, extruded-aluminum stops and preformed gaskets.
    - a. Provide nonremovable glazing stops on outside of door.

## 2.6 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
  - 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products or products equivalent in function and comparable in quality to named products complying with BHMA standard referenced.
  - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
  - 3. Opening-Force Requirements:
    - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
    - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
  - 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum

- requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.
  - E. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
  - F. Manual Flush Bolts: BHMA A156.16, Grade 1.
  - G. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
  - H. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
  - I. Cylinders: As specified in Section 087100 "Door Hardware"
    1. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE".
  - J. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
  - K. Operating Trim: BHMA A156.6.
  - L. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
  - M. Concealed Overhead Holders: BHMA A156.8, Grade 1.
  - N. Surface-Mounted Holders: BHMA A156.16, Grade 1.
  - O. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
  - P. Weather Stripping: Manufacturer's standard replaceable components.
    1. Compression Type: Made of ASTM D 2000, molded neoprene.
    2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
  - Q. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
  - R. Silencers: BHMA A156.16, Grade 1.
  - S. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.
  - T. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

## 2.7 ACCESSORIES

- A. Automatic Door Operators: Section 087100 "Door Hardware"
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.

2. Reinforce members as required to receive fastener threads.
  3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC Filler.

## 2.8 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitered.
  3. Physical and thermal isolation of glazing from framing members.
  4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  5. Provisions for field replacement of glazing from interior.
  6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Storefront Framing: Fabricate components for assembly using shear-block system.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At exterior doors, provide compression weather stripping at fixed stops.
  2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
  2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

- J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## **2.9 ALUMINUM FINISHES**

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
  - 1. Color: Refer to Drawings.

## **2.10 SOURCE QUALITY CONTROL**

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

### **3.3 INSTALLATION**

- A. General:
  - 1. Comply with manufacturer's written instructions.
  - 2. Do not install damaged components.
  - 3. Fit joints to produce hairline joints free of burrs and distortion.
  - 4. Rigidly secure nonmovement joints.
  - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
  - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
  - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
  - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 088000 "Glazing."

- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
  - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
  - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

### 3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
  - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
  - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  - 3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
  - 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
  - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Perform a minimum of three tests in areas as directed by Architect.
    - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 50 percent completion.
  - 2. Air Infiltration: ASTM E283 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
    - a. Perform a minimum of four tests in areas as directed by Architect.
    - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 50 percent completion.
  - 3. Water Penetration: ASTM E1105 at a minimum uniform static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
- C. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
  - 1. Test a minimum of **two** areas on each building facade.
  - 2. Repair installation areas damaged by testing.

- D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

**3.6 MAINTENANCE SERVICE**

- A. Entrance Door Hardware:
  - 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
  - 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

**3.7 ENTRANCE DOOR HARDWARE SETS**

- A. Refer to door hardware schedule Section 087100

END OF SECTION 084113

**SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes glazed aluminum curtain walls.

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
  - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  - 2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
  - 4. Include details of provisions for temporary construction in connection to, and continuity with, existing adjacent building shell - including but not limited to thermal, weather, and air infiltration barriers.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and field-testing agency.

- B. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
  - 1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
- C. Product Test Reports: For glazed aluminum curtain walls, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranties: For special warranties.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

## **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- C. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.

## **1.8 WARRANTY**

- A. Special Assembly Warranty: Installer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    - d. Water penetration through fixed glazing and framing areas.



- e. Failure of operating components.
  - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied paint finishes within specified warranty period.
- 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied color anodic finishes within specified warranty period.
- 1. Warranty Period: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Structural Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
  - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 4.1 m (13 feet 6 inches) and to 1/240 of clear span plus 6.35 mm (1/4 inch) for spans greater than 4.1 m (13 feet 6 inches) or an amount that restricts edge deflection of individual glazing lites to 19.1 mm (3/4 inch), whichever is less.
  - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 3.2 mm (1/8 inch), whichever is smaller.
- E. Structural: Test according to ASTM E 330 as follows:
  - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.30 L/s per sq. m (0.06 cfm/sq. ft.) at a static-air-pressure differential of 300 Pa (6.24 lbf/sq. ft.) .
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 480 Pa (10 lbf/sq. ft.).
- H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15480 Pa (lbf/sq. ft.).
  2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- I. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
1. Overall system profiles and gaskets to accommodate interstory vertical displacement of design displacement when tested in accordance to AAMA 501.4. The curtain wall shall pass the following:
    - a. All functions remain unimpaired with no visible damage.
    - b. Post-design displacement performance (e.g. air infiltration, water leakage, structural performance, etc.) shall remain within specified allowable limits without adjustments or repair
  2. Overall system profiles and gaskets to accommodate interstory horizontal displacement of 1.5 times the design displacement when tested in accordance to AAMA 501.4. The curtain wall shall pass the following:
    - a. No glass breakage or glass fallout is allowed
    - b. No wall components may fall off. Trim may not be visibly disengaged.
- J. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 2.55 W/sq. m x K (0.43 Btu/sq. ft. x h x deg F) as determined according to NFRC 100.
  2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.
  3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 55 as determined according to NFRC 500.
- K. Windborne-Debris Impact Resistance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 4.
1. Large-Missile Test: For glazed openings located within 9.1 m (30 feet) of grade.
  2. Small-Missile Test: For glazed openings located more than 9.1 m (30 feet) above grade.
- L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 67 deg C (120 deg F), ambient; 100 deg C (180 deg F), material surfaces.
  2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
    - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 82 deg C (180 deg F) .
    - b. Low Exterior Ambient-Air Temperature: -20 deg F.
- M. Structural-Sealant Joints:
1. Designed to carry gravity loads of glazing.
  2. Designed to produce tensile or shear stress of less than 138 kPa (20 psi).
- N. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Perform preconstruction adhesion testing of structural sealant adhesion to curtain wall members having specified finishes applied.
  2. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  3. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

## 2.2 SOURCE LIMITATIONS

- A. Obtain all components of curtain-wall system and storefront system, including frame, entrances, sun control and accessories, from single manufacturer.

## 2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
1. Kawneer
    - a. 1600 Wall System 1 Curtain Wall.
      - 1) Site line: 2-1/2"
      - 2) Outside-glazed pressure plate format.
      - 3) System depth: 6" for 1" insulating glazing.
- B. Acceptable Manufacturers:
1. Tubelite; 400TU
  2. Wausau; 6250 SuperWall Series Thermal Curtainwall
  3. YKK: YCW 750 SSG and XT
  4. Oldcastle Building Envelope Reliance Cassette Wall
- C. Source Limitations: Obtain all components of curtain wall system, including framing, insulated panels, stool trim, entrances, and accessories, from single manufacturer.

## 2.4 MATERIALS

- A. Aluminum Extrusions:

1. Alloy and temper recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, and application of required finish.
  2. Not less than 0.070" (1.8 mm) wall thickness at any location for the main frame.
  3. Complying with ASTM B221: 6063-T6 alloy and temper.
- B. Aluminum sheet Alloy:
1. Shall meet the requirements of ASTM B209.
- C. Fasteners:
1. Aluminum, nonmagnetic stainless steel or other materials must be non-corrosive and compatible with aluminum members, trim hardware, anchors, and other components
- D. Anchors, Clips, and Accessories:
1. Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating.
  2. Anchors, clips, and accessories shall provide sufficient strength to withstand the design pressure indicated.
1. Pressure Plate:
    1. Pressure plate shall be aluminum.
    2. Pressure plate shall be fastened to the mullion with stainless steel screws.
  2. Reinforcing Members:
    1. Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating.
    2. Reinforcing members must provide sufficient strength to withstand the design pressure indicated.
  3. Sealant:
    1. For sealants required within fabricated curtain wall system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.
  4. Thermal Barrier:
    1. Thermal separator shall be extruded of a silicone compatible elastomer that provides a minimum 1/4" (6.3 mm) separation.
  5. Tolerances:
    1. References to tolerances for wall thickness and other cross-sectional dimensions of glazed curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

## 2.5 CURTAIN WALL FRAMING

1. Framing Members:

1. Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads
2. Glazing System: Four-sided captured
3. Glazing Plane: Front
2. Glass:
  1. Insulating glass: 1" (25.4 mm)
3. Brackets and Reinforcements:
  1. Manufacturer's standard high-strength aluminum with non-staining, non-ferrous shims for aligning system components.
4. Framing Sealants:
  1. Shall be suitable for glazed aluminum curtain wall as recommended by sealant manufacturer.
5. Fasteners and Accessories:
  1. Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories must be compatible with adjacent materials.
  2. Where exposed, fasteners and accessories shall be stainless steel.
6. Perimeter Anchors:
  1. When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.
7. Packing, Shipping, Handling, and Unloading:
  1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
8. Storage and Protection:
  1. Store materials so that they are protected from exposure to harmful weather conditions.
  2. Handle material and components to avoid damage.
  3. Protect material against damage from elements, construction activities, and other hazards before, during, and after installation.

## 2.6 GLAZING

1. Glazing to meet requirements in Division 08 Glazing Section.
2. Glazing Gaskets:
  1. Gaskets to meet requirements of ASTM C864.
3. Spacers and Setting Blocks:
  1. Manufacturer's standard elastomeric type

4. Bond-Breaker Tape:
  1. Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
5. Glazing Sealants:
  1. As recommended by manufacturer for joint type.

## **2.7 OPERABLE UNITS**

1. Doors comply with Division 08 Aluminum-Framed Entrances and Storefronts Section.

## **2.8 ACCESSORY MATERIALS**

1. Bituminous Paint:
  1. Cold-applied asphalt-mastic paint
  2. Complies with SSPC-Paint 12 requirements except containing no asbestos
  3. Formulated for 30-mil (0.762 mm) thickness per coat

## **2.9 FABRICATION**

1. Extrude or form aluminum shapes before finishing.
2. Fabricate components that, when assembled, have the following characteristics:
  1. Profiles that are sharp, straight, and free of defects or deformations
  2. Accurately fitted joints
  3. Physical and thermal isolation of glazing from framing members
  4. Accommodations for thermal and mechanical movements of glazing and framing that maintain required glazing edge clearances
  5. Provisions for field replacement of glazing from exterior
  6. Fasteners, anchors, and connection devices that are concealed from view to the greatest extent possible
  7. Internal weeping system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior
3. Curtain Wall Framing:
  1. Fabricate components for assembly using shear block system following manufacturer's standard installation instructions.
4. After fabrication, clearly mark components to identify their locations in project according to shop drawings.

## 2.10 ALUMINUM FINISHES

1. Finish designations that are prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Factory Finishing:
  1. AAMA 611, Architectural Class II Clear Anodic Coating (Color #17 Clear) (Standard)

## PART 3 EXECUTION

### 3.1 EXAMINATION

1. With installer present, examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
2. Proceed with installation only after correcting unsatisfactory conditions.

### 3.2 INSTALLATION

1. Curtain Wall System Installation:
  1. Install curtain wall systems plumb, level, and true to line, without warp or rack of frames, within manufacturer's prescribed tolerances, and complying with installation instructions.
  2. Provide support and anchor in place.
  3. Dissimilar Materials:
    1. Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
  4. Glazing:
    1. Glass shall be outside-glazed.
    2. Glass shall be held in place with extruded aluminum pressure plates anchored to the mullion using stainless steel fasteners that are spaced no more than 9" (228.6 mm) on center.
  5. Water Drainage
    1. Each light of glass shall be compartmentalized using joint plugs and silicone sealant to divert water to the horizontal weep locations.
    2. Weep holes shall be located in the horizontal pressure plates and covers to divert water to the exterior of the building.
2. Related Products Installation:
  1. Sealants (Perimeter):
    1. Refer to Joint Treatment (Sealants) Section.
  2. Glass:
    1. Refer to Glass and Glazing Section.
    2. Reference: ANSI Z97.1, CPSC 16 CFR 1201, and GANA Glazing Manual.

### 3.3 FIELD QUALITY CONTROL

1. Field Tests:
  1. Architect shall select curtain wall units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter-caulked, and cured.
  2. Conduct tests for air infiltration and water penetration with manufacturer's representative present.
  3. Tests that do not meet the specified performance requirements and units that have deficiencies shall be corrected as part of the contract amount.
  4. Testing shall be performed per AAMA 503 by a qualified independent testing agency. Refer to Testing Section for payment of testing and testing requirements.
  5. Air Infiltration Tests:
    1. Conduct tests in accordance with ASTM E 783.
    2. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.09 cfm/ft<sup>2</sup>, whichever is greater.
  6. Water Infiltration Tests:
    1. Conduct tests in accordance with ASTM E 1105.
    2. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 8 psf (383 Pa).
2. Manufacturer's Field Services:
  1. Upon owner's written request, provide periodic site visit by manufacturer's field service representative.

### 3.4 ADJUSTING, CLEANING, AND PROTECTION

1. Adjusting: Not applicable.
2. Protection:
  1. Protect installed product's finish surfaces from damage during construction.
  2. Protect aluminum curtain wall system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
3. Cleaning:
  1. Repair or replace damaged installed products.
  2. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.
  3. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during the construction period.

E. Remove construction debris from project site and legally dispose of debris.

END OF SECTION 084413



**SECTION 085653 – SECURITY WINDOWS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Bullet-resistant fixed aluminum window assemblies.

**1.2 REFERENCES**

- A. American Welding Society (AWS) D1.2/D1.2M – Structural Welding Code – Aluminum.
- B. American Architectural Manufacturers Association (AAMA) 611 – Voluntary Specification for Anodized Architectural Aluminum.
- C. ASTM International (ASTM) B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. Underwriters Laboratories (UL 752 – Bullet Resisting Equipment).

**1.3 ACTION SUBMITTALS**

- A. Refer to Section 013300 Submittals.
- B. Product Data: For each type of window
- C. Shop Drawings: Include plans, elevations, sections, details, anchorage to other work.

**1.4 INFORMATION SUBMITTALS**

- A. Product Test Reports: Indicating compliance with requirements.

**1.5 CLOSEOUT SUBMITTALS**

- A. Cleaning Instructions

**1.6 DELIVERY, STORAGE AND HANDLING****1.7 WARRANTY**

- A. Special Warranty for Security Glass - Acrylic or approved equal.
  - 1. Manufacturer agrees to replace glass units that deteriorate within a period of 20 years. Deterioration includes the development of defects that are not caused by breakage, or

improper maintenance and cleaning. Defects as identified by the glass manufacturer the include:

- a. Discoloration of coating in excess of 3% when tested in accordance with ASTM D 1003 - Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.
- b. Chipping of abrasions resistant coating

B. Special Warranty for Security Glass - Laminate (Lexgard) or approved equal

- 1. Manufacturer agrees to replace glass units that deteriorate within a period of 10 years. Deterioration includes the development of defects that are not caused by breakage, or improper maintenance and cleaning. Defects as identified by the glass manufacturer the include:
  - a. Structural Delamination
  - b. Coating Failure
  - c. Haze of more than 15%

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. **(GL-6)** Baffle Transaction Windows:

- 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Armortex WI-TW-AL-BA
- 2. Acceptable Manufacturers:
  - a. Total Security Solutions
  - b. Insulgard Security Products

B. **(GL-7)** Transaction Windows:

- 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Armortex WI-TW-CT-NV
- 2. Acceptable Manufacturers:
  - a. Total Security Solutions
  - b. Insulgard Security Products

C. **(GL-8)** Fixed Window:

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Armortex WI-FW-CF-RS
2. Acceptable Manufacturers:
  - a. Total Security Solutions
  - b. Insulgard Security Products

## 2.2 MATERIALS

- A. Aluminum Extrusions:
  1. ASTM B221, Alloy and temper designations are in accordance with ANSI H35.1/H35.1M.
- B. Bullet-Resistant Composite: UL Listed Bullet Resistant Composite by manufacturer.
- C. Glazing for panels and support buttress:
  1. Level 2 - 1 inch thickness
- D. Fasteners and Fittings
  1. Clips, fasteners and anchors: Manufacturer standards stainless steel, chrome
  2. Bottom Glass Rail: Anodized Aluminum "U" Channel to accommodate thickness of glass.

## 2.3 PERFORMANCE CRITERIA

- A. Ballistic Resistant: Level 2 in accordance with UL 752 – Testing for Ballistic Resistance for the framing and glazing.

## 2.4 FABRICATION

- A. Fabricate from manufacturer's standard materials to comply with indicated ballistic resistance requirements.
- B. Frames:
  1. Fabricate from aluminum extrusions lined with bullet-resistant composite.
  2. Weld frame corners; knock-down and mechanical joints not acceptable.
  3. Frame modules capable of being joined with other frame modules to form continuous line.
  4. Replacement of glazing from secure side of window, not requiring removal of frame from opening.
- C. Welding: In accordance with AWS D1.2/D1.2M. Grind exposed welds flush and smooth.
- D. Finish work neat and free from defects.

- E. Allowable Tolerances: Plus or minus 1/16 inch for frame opening width, height, diagonal dimensions, and overall width and height (outside to outside).

## 2.5 FINISHES

- A. Aluminum: AAMA 611, Architectural Class I anodized, clear.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Verify field dimensions of opening prior to fabrication of counterline window.
- B. Coordinate structural requirements to ensure proper attachment and support.

### 3.2 INSTALLATION

- A. Install counterline windows in accordance with manufacturer's recommendations and approved shop drawings.
- B. Set plumb, square and level.
- C. Secure to adjacent construction using fastener type best suited to application.
- D. Field alterations to window assemblies not permitted unless approved in advance by manufacturer and Architect.

### 3.3 ADJUSTING

- A. Touch up minor scratches and abrasions in finish coat to match factory finish.

### 3.4 CLEANING

- A. Clean security window surfaces after installation, avoiding damage to finishes. Remove excess glazing and sealant compound and dirt.

### 3.5 PROTECTION

- A. Protect transaction windows damage during construction operations. If damage occurs, remove and replace as required to provide windows in their original, undamaged condition.

END OF SECTION 085653

**SECTION 087100 - DOOR HARDWARE**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes commercial door hardware for the following:
  - 1. Swinging doors.
  - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical door hardware.
  - 3. Automatic operators.
  - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
  - 1. Division 08 Section "Hollow Metal Doors and Frames".
  - 2. Division 08 Section "Flush Wood Doors".
  - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
  - 4. Division 08 Section "Automatic Door Operators".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
  - 8. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

### 1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
    - h. Warranty information for each product.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
  1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
  - b. Complete (risers, point-to-point) access control system block wiring diagrams.
  - c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- E. Automatic Operator Supplier Qualifications: Power operator products and accessories are required to be supplied and installed through the Norton Preferred Installer (NPI) program. Suppliers are to be factory trained, certified, and a direct purchaser of the specified power operators and be responsible for the installation and maintenance of the units and accessories indicated for the Project.
- F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
  - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
  - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
  - 1. Function of building, purpose of each area and degree of security required.
  - 2. Plans for existing and future key system expansion.
  - 3. Requirements for key control storage and software.
  - 4. Installation of permanent keys, cylinder cores and software.
  - 5. Address and requirements for delivery of keys.
- I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
  - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
  - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
  - 3. Review sequence of operation narratives for each unique access controlled opening.
  - 4. Review and finalize construction schedule and verify availability of materials.
  - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.



## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

## **1.6 COORDINATION**

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

## **1.7 WARRANTY**

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

**1.8 MAINTENANCE SERVICE**

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

**PART 2 - PRODUCTS**

**2.1 SCHEDULED DOOR HARDWARE**

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
  - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

**2.2 HANGING DEVICES**

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
  - 1. Quantity: Provide the following hinge quantity:
    - a. Two Hinges: For doors with heights up to 60 inches.
    - b. Three Hinges: For doors with heights 61 to 90 inches.
    - c. Four Hinges: For doors with heights 91 to 120 inches.
    - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
  - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
    - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    - b. Sizes from 3'6" to 4'0": 5" standard or heavy weight as specified.
  - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

- a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
  - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
- a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
- a. Hager Companies (HA) - BB Series, 5 knuckle.
  - b. McKinney (MK) - TA/T4A Series, 5 knuckle.
  - c. dormakaba Best (ST) - F/FBB Series, 5 knuckle.
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
- a. Hager Companies (HA).
  - b. Pemko (PE).
  - c. Dormakaba Best (ST).

## 2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
1. Manufacturers:
- a. Hager Companies (HA) - ETW-QC (# wires) Option.
  - b. McKinney (MK) - QC (# wires) Option.
  - c. Dormakaba Best (ST) - C Option.
- B. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
  - a. Pemko (PE) - EL-CEPT Series.
  - b. Securitron (SU) - EL-CEPT Series.
  - c. Dormakaba Best (ST) EPT-12C Series.

C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:
  - a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
  - b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:
  - a. Hager Companies (HA) - Quick Connect.
  - b. McKinney (MK) - QC-C Series.
  - c. Dormakaba Best (ST) - WH Series.

## 2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

4. Manufacturers:
  - a. Door Controls International (DC).
  - b. Rockwood (RO).
  - c. Trimco (TC).

B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:
  - a. Door Controls International (DC).
  - b. Rockwood (RO).

- c. Trimco (TC).
- C. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
- 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
  - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
  - 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
  - 4. Pulls, where applicable, shall be provided with a 10" clearance from the finished floor on the push side to accommodate wheelchair accessibility.
  - 5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
  - 6. Manufacturers:
    - a. Hiawatha, Inc. (HI).
    - b. Rockwood (RO).
    - c. Trimco (TC).

## 2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- 1. Manufacturers:
    - a. Arrow (AW).
    - b. Yale Commercial (YA).
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
- 1. Threaded mortise cylinders with rings and cams to suit hardware application.
  - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
  - 4. Tubular deadlocks and other auxiliary locks.
  - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
  - 6. Keyway: Manufacturer's Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
  2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
  3. New System: Key locks to a new key system as directed by the Owner.
- D. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
  2. Master Keys (per Master Key Level/Group): Five (5).
  3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.
- F. Key Registration List (Bitting List):
1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
  2. Provide transcript list in writing or electronic file as directed by the Owner.

## 2.6 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
1. Manufacturers:
    - a. Lund Equipment (LU).
    - b. MMF Industries (MM).
    - c. Telkee (TK).

## 2.7 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.
1. Heavy duty cylindrical locks shall have a seven-year warranty.
  2. Vertical Impact: Exceed 100 vertical impacts (20 times ANSI/BHMA A156.2 requirements).
  3. Furnish with solid cast levers, standard 2 3/4" backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
  4. Locks are to be non-handed and fully field reversible.
  5. Manufacturers:

- a. Arrow Locks (AW)
- b. Corbin Russwin Hardware (RU)
- c. Yale Commercial (YA) 5400LN Series.

## 2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
  2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
  3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
  2. Strikes for Bored Locks and Latches: BHMA A156.2.
  3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
  4. Dustproof Strikes: BHMA A156.16.

## 2.9 ELECTRIC STRIKES

- A. Standard Electric Strikes: Electric strikes conforming to ANSI/BHMA A156.31, Grade 1, for use on non-rated or fire rated openings. Strikes shall be of stainless steel construction tested to a minimum of 1500 pounds of static strength and 70 foot-pounds of dynamic strength with a minimum endurance of 1 million operating cycles. Provide strikes with 12 or 24 VDC capability, fail-secure unless otherwise specified. Where specified provide latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike.
1. Manufacturers:
    - a. HES (HS) - 1500/1600 Series.
    - b. Rutherford Controls (RC) - F2100/F2300 Series.
    - c. Trine Access Technology (TR) - 4100 Series.
- B. Surface Mounted Rim Electric Strikes: Surface mounted rim exit device electric strikes conforming to ANSI/BHMA A156.31, Grade 1, and UL Listed for both Burglary Resistance and for use on fire rated door assemblies. Construction includes internally mounted solenoid with two heavy-duty, stainless steel locking mechanisms operating independently to provide tamper resistance. Strikes tested for a minimum of 500,000 operating cycles. Provide strikes with 12 or 24 VDC capability supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike. Strike requires no cutting to the jamb prior to installation.

1. Manufacturers:
  - a. HES (HS) - 9400/9500/9600/9700/9800 Series.
  - b. Rutherford Controls (RC) - 0162/F0162/0163/0563 Series.
- C. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

## 2.10 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
  1. Exit devices shall have a five-year warranty.
  2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
  3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
  4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
  5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
  6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
    - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
  7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
  8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.



10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
    - a. Arrow (AW) - 3700/3800/3900, 4800/4900 Series.
    - b. dormakaba Best (PR) - Apex 2000 Series.
    - c. Yale (YA) - 7000 Series.

## 2.11 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
  2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
  3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
  4. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - ED5000 Series.
    - b. dormakaba Precision (PR) - Apex 2000 Series.
    - c. Yale (YA) - 7000 Series.

## 2.12 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
  4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
  5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
  6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Commercial Duty): ANSI/BHMA 156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units standard.
1. Manufacturers:
    - a. Arrow (AW) - DC500 Series.
    - b. Norton Rixson (NO) - 8500 Series.
    - c. Yale Commercial (YA) - 3500 Series.

### **2.13 ELECTROHYDRAULIC DOOR OPERATORS**

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:
1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
  2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.
- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. LCN Closers (LC) - 4640 Series.
  2. Norton Door Controls (NO) - 6000 Series.
  3. Stanley Security Solutions (ST) – D-4990 Series.

## 2.14 ACTIVATION DEVICES

- A. General: Provide activation devices in accordance with ANSI/BHMA A156.19 standard, for condition of exposure indicated and for long term, maintenance free operation under normal traffic load operation. Coordinate activation control with electrified hardware and access control interfaces. Activation switches are standard SPST, with optional DPDT availability.
- B. Push-Plate Switch: Momentary contact door control switch with push-plate actuator.
  1. Configuration: Square or round push-plate control switch with single or double gang junction box mounting. Provide narrow profile face plate where indicated for jamb or mullion mounting.
    - a. Mounting Location: As indicated on Drawings.
  2. Push-Plate Material: Stainless steel.
  3. Message: International symbol of accessibility with "Push (Press) to Open (Operate)" text.
  4. Manufacturers:
    - a. BEA Sensors (BS) – PBS45 Series.
    - b. Norton Door Controls (NO) – 500 Series.
    - c. Wikk Industries (WI) – 4x4 Series.

- C. Touch Less Wall Switch: Momentary contact door control switch with movement required activation. Single or double gang box junction box mounting.
1. Doppler radar sensor.
  2. Mounting Location: As indicated on Drawings.
  3. Manufacturers:
    - a. BEA Sensors (BS) – MS Series.
    - b. Norton Door Controls (NO) – 700 Series.
    - c. Securitron (SU) – WSS Series.

## 2.15 ACCESSORIES

- A. Signage: As required by cited ANSI/BHMA A156.19 standard for the type of operator.

## 2.16 ARCHITECTURAL TRIM

- A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
  2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
  3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
  4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
    - a. Stainless Steel: 300 grade, 050-inch thick.
  5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
  6. Manufacturers:
    - a. Hiawatha, Inc. (HI).
    - b. Rockwood (RO).
    - c. Trimco (TC).

## 2.17 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  - 1. Manufacturers:
    - a. Hiawatha, Inc. (HI).
    - b. Rockwood (RO).
    - c. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  - 1. Manufacturers:
    - a. Norton Rixson (RF).
    - b. Rockwood (RO).
    - c. Sargent Manufacturing (SA).

## 2.18 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
  - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
  - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
  - 1. National Guard Products (NG).
  - 2. Pemko (PE).
  - 3. Reese Enterprises, Inc. (RE).

## **2.19 ELECTRONIC ACCESSORIES**

- A. Request-to-Exit Motion Sensor: Request-to-Exit Sensors motion detectors specifically designed for detecting exiting through a door from the secure area to a non-secure area. Include built-in timers (up to 60 second adjustable timing), door monitor with sounder alert, internal vertical pointability coverage, 12VDC or 24VDC power and selectable relay trigger with fail safe/fail secure modes.
  - 1. Manufacturers:
    - a. Alarm Controls (AK) - SREX Series.
    - b. Securitron (SU) - XMS Series.
- B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
  - 1. Manufacturers:
    - a. Security Door Controls (SD) - DPS Series.
    - b. Securitron (SU) - DPS Series.

## **2.20 FABRICATION**

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

## **2.21 FINISHES**

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

### **3.2 PREPARATION**

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

### **3.3 INSTALLATION**

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
  - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

### **3.4 FIELD QUALITY CONTROL**

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
  - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

### **3.5 ADJUSTING**

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

### **3.6 CLEANING AND PROTECTION**

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.



**3.7 DEMONSTRATION**

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

**3.8 DOOR HARDWARE SETS**

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
  - 1. Quantities listed are for each pair of doors, or for each single door.
  - 2. The supplier is responsible for handing and sizing all products.
  - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
- B. Manufacturer's Abbreviations:

- 1. MK - McKinney
- 2. PE - Pemko
- 3. RO - Rockwood
- 4. YA - Yale
- 5. HS - HES
- 6. RF - Rixson
- 7. NO - Norton
- 8. SU - Securitron
- 9. LU - Lund Equipment Co

**Hardware Sets****Set: 1.0**

Doors: 164A, 164B, 165A, 167B, 168A

Description: OH DOOR

1 Hardware By Others Hardware By Door Supplier

**Set: 2.0**

Doors: 100A

Description: EXTERIOR PAIR ALD DUMMY EXIT X PULL X AUTO OPERATOR / DMY OPERATOR

1 Continuous Hinge	CFMSLF/K-HD1		PE	087100
1 Continuous Hinge	CFMSLF/K-HD1 PT		PE	087100
1 Concealed Vert Rod Exit, Nightlatch	7220 B MELR 481F 1109 x 6-Pin GB	630	YA	087100
1 Concealed Vert Rod Exit, Dummy Trim	7220 480F	630	YA	087100
1 Mortise Cylinder	2153 GB	626	YA	087100
2 Conc Overhead Stop	6-336	630	RF	087100
1 Automatic Opener	6000 Series	689	NO	087100
1 Dummy Operator	6000 DMY	689	NO	087100
1 Threshold	2009APK		PE	087100
1 Set Weatherstrip	by Door Manufacturer			
2 Sweep	3452AV		PE	087100
1 Keyswitch	MKA		SU	087100
1 Door Switch, actuator	505		NO	087100
1 Wall Switch, touchless	700		NO	087100

Notes: TURN EXTERIOR ACTUATOR SWITCH ON DURING BUSINESS HOURS. THIS SWITCH WILL RETRACT THE LATCH RODS OF THE ACTIVE DOOR LEAF. ACTUATOR SWITCH IS ALWAYS ACTIVE FROM INTERIOR FOR ASSISTED EGRESS.

**Set: 2.1**

Doors: 145A

Description: EXTERIOR PAIR HMD CVR NL/EL EXIT X PULL X AUTO OPERATOR / DMY OPERATOR

1 Continuous Hinge	CFMHD1		PE	087100
1 Continuous Hinge	CFMHD1 PT		PE	087100
1 Concealed Vert Rod Exit, Nightlatch	7160 B MELR 681F 1109 x 6-Pin	630	YA	087100
1 Concealed Vert Rod Exit, Dummy Trim	7160 680F	630	YA	087100
1 Mortise Cylinder	2153 GB	626	YA	087100
2 Conc Overhead Stop	6-336	630	RF	087100
1 Automatic Opener	6000 Series	689	NO	087100

1 Dummy Operator	6000 DMY	689	NO	087100
1 Threshold	2009APK		PE	087100
1 Gasketing	2891AS		PE	087100
1 Rain Guard	346C		PE	087100
2 Sweep	3452AV		PE	087100
2 Astragal	29324CNB (w/Trio E Door)		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
1 Keyswitch	MKA		SU	087100
1 Door Switch, actuator	505		NO	087100
1 Wall Switch, touchless	700		NO	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 Electric Power Transfer	EL-CEPT	630	SU	087100

Notes: TURN EXTERIOR ACTUATOR SWITCH ON DURING BUSINESS HOURS. THIS SWITCH WILL RETRACT THE LATCH RODS OF THE ACTIVE DOOR LEAF. ACTUATOR SWITCH IS ALWAYS ACTIVE FROM INTERIOR FOR ASSISTED EGRESS.

**Set: 3.0**

Doors: 113, 135C

Description: EXTERIOR HMD RIM EXIT X ELEC STRIKE PR CLOSER

1 Continuous Hinge	CFMHD1		PE	087100
1 Rim Exit Device, Nightlatch	6200 481F 1109 x 6-Pin GB	630	YA	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Electric Strike	9600	630	HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Blade Stop	891	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Threshold	2009APK		PE	087100
1 Gasketing	2891AS		PE	087100
1 Sweep	3452AV		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 4.0**

Doors: 200

Description: EXTERIOR ALD RIM EXIT X ELEC STRIKE PR CLOSER

1 Continuous Hinge	CFMSLF/K-HD1		PE	087100
1 Rim Exit Device, Nightlatch	6200 481F 1109 x 6-Pin GB	630	YA	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Electric Strike	9600	630	HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Blade Stop	891	689	YA	087100
1 Drop Plate	3148	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Threshold	2009APK		PE	087100
1 Set Weatherstrip	by Door Manufacturer			
1 Sweep	3452AV		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 5.0**

Doors: 155B

Description: EXTERIOR HMD RIM EXIT ELR CPS CLOSER

1 Continuous Hinge	CFMHD1 PT		PE	087100
1 Rim Exit Device, Nightlatch	7100 B MELR 681F 1109 x 6-Pin GB	630	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Threshold	2009APK		PE	087100
1 Gasketing	2891AS		PE	087100
1 Rain Guard	346C		PE	087100
1 Sweep	3452AV		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
1 Position Switch	DPS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

1 Electric Power Transfer EL-CEPT 630 SU 087100

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 6.0**

Doors: 165B, 167C

Description: EXTERIOR HMD STOREROOM LOCK X ELEC STRIKE PR CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3386/T4A4386 NRP FT 4-1/2" x 4-1/2"	US32D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Threshold	2009APK		PE	087100
1 Gasketing	2891AS		PE	087100
1 Rain Guard	346C		PE	087100
1 Sweep	3452AV		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS. NO CARD READER, OR RELATED HARDWARE

**Set: 7.0**

Doors: 170

Description: EXTERIOR HMD STOREROOM LOCK CPS CLOSER WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3386/T4A4386 NRP 5" x 4-1/2"	US32D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Threshold	273x3AFG		PE	087100
1 Gasketing	2891AS		PE	087100
1 Rain Guard	346C		PE	087100
1 Sweep	3452AV		PE	087100
1 Position Switch	DPS		SU	087100
1 KnoxBox	3200, Surface Mount		Dk Bz	

**Set: 8.0**

Doors: 180A, 207

Description: EXTERIOR HMD STOREROOM EXIT PR CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3386/T4A4386 NRP FT 4-1/2" x 4-1/2"	US32D	MK	087100
1 Rim Exit Device, Nightlatch	6100ED PB627F 1109 x 6-Pin GB	630	YA	087100
1 Surface Closer	PR3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Threshold	2009APK		PE	087100
1 Gasketing	2891AS		PE	087100
1 Rain Guard	346C		PE	087100
1 Sweep	3452AV		PE	087100
1 Position Switch	DPS		SU	087100

**Set: 9.0**

Doors: 100B, 145B

Description: PAIR ALD CVR EXIT ELR X AUTO OPERATOR / DMY OPERATOR

2 Continuous Hinge	CFMSLF/K-HD1 PT		PE	087100
1 Concealed Vert Rod Exit, Nightlatch	7220 B MELR 481F 1109 x 6-Pin GB	630	YA	087100
1 Concealed Vert Rod Exit, Dummy Trim	7220 B MELR 480F	630	YA	087100
2 Conc Overhead Stop	6-336	630	RF	087100
1 Automatic Opener	6000 Series	689	NO	087100
1 Dummy Operator	6000 DMY	689	NO	087100
2 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
2 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
2 Position Switch	DPS		SU	087100
2 Wall Switch, touchless	700		NO	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. PROGRAM ACTUATOR SWITCHES AS DIRECTED BY SECURITY FOR ACCESS CONTROL TIMES OR BY CARD READER ACTIVATION. ALWAYS FREE EGRESS.

**Set: 10.0**

Doors: 101, 180D

Description: RIM EXIT STOREROOM X ELEC STRIKE PR CLOSER WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 5" x 4-1/2"	US26D	MK	087100
1 Rim Exit Device, Classroom	6100ED PB626F 1109 x 6-Pin GB	630	YA	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Electric Strike	9400	630	HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 11.0**

Doors: 147

Description: STOREROOM LOCK X ELEC STRIKE CLOSER FLR STOP

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Floor Door Stop, short	RM855 (dome top)	US32D	RO	087100
3 Silencer	608		RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 12.0**

Doors: 167D

Description: STOREROOM LOCK X ELEC STRIKE CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Surface Closer	3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
3 Silencer	608		RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 13.0**

Doors: 152B

Description: STOREROOM LOCK X ELEC STRIKE PR CLOSER WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 5" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.



**Set: 14.0**

Doors: 153

Description: STOREROOM LOCK X ELEC STRIKE PR CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Surface Closer	PR3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 15.0**

Doors: 154

Description: PAIR HMD CVR EXIT ELR CPS CLOSER

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Concealed Vert Rod Exit, Nightlatch	7160 B MELR 681F 1109 x 6-Pin	630	YA	087100
1 Concealed Vert Rod Exit, Dummy Trim	7160 B MELR 680F	630	YA	087100
2 Surface Closer, CPS	3531	689	YA	087100
2 Silencer	608		RO	087100
2 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
2 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
2 Position Switch	DPS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			
2 Electric Power Transfer	EL-CEPT	630	SU	087100

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 16.0**

Doors: 167A

Description: PAIR HMD STOREROOM LOCK X ELEC STRIKE AFB CPS CLOSER

5 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 QC12 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Flush Bolt	2942/2842 per dr mtrl	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
1 Coordinator	2600	Black	RO	087100
2 Mounting Bracket	2601 Mounting Brackets	Black	RO	087100
2 Surface Closer, CPS	3531	689	YA	087100
1 Astragal Set	by Door Manufacturer			
2 Silencer	608		RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
2 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

**Set: 17.0**

Doors: 168B, 175

Description: PAIR HMD STOREROOM LOCK X ELEC STRIKE MFB CPS CLOSER

5 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 QC12 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Dust Proof Strike	570	US26D	RO	087100
2 Flush Bolt	555/557 per dr mtrl	US26D	RO	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
2 Surface Closer, CPS	3531	689	YA	087100
1 Astragal Set	by Door Manufacturer			
2 Silencer	608		RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100

1 ElectroLynx Harness	QC- (size to door width/hardware)	MK	087100
2 Position Switch	DPS	SU	087100
1 Motion Sensor	XMS	SU	087100
1 Power Supply	AQD appropriate to hardware requirements	SU	087100
1 CARD READER	provided by State security vendor		

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 18.0**

Doors: 176

Description: PAIR HMD STOREROOM LOCK X ELEC STRIKE MFB CLOSER

5 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 QC12 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Dust Proof Strike	570	US26D	RO	087100
2 Flush Bolt	555/557 per dr mtrl	US26D	RO	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Electric Strike	1006	630	HS	087100
1 SMART Pac Bridge Rectifier	2005M3		HS	087100
2 Surface Closer	3501	689	YA	087100
2 Wall Stop	RM861	US32D	RO	087100
1 Astragal Set	by Door Manufacturer			
2 Silencer	608		RO	087100
1 ElectroLynx Harness	QC-hinge/power transfer to ceiling		MK	087100
1 ElectroLynx Harness	QC- (size to door width/hardware)		MK	087100
2 Position Switch	DPS		SU	087100
1 Motion Sensor	XMS		SU	087100
1 Power Supply	AQD appropriate to hardware requirements		SU	087100
1 CARD READER	provided by State security vendor			

Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL OR MANUAL KEY. ALWAYS FREE EGRESS.

**Set: 19.0**

Doors: 118

Description: STOREROOM LOCK CLOSER OH STOP

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surf Overhead Stop	10-X36	630	RF	087100

1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
3 Silencer	608		RO	087100

**Set: 20.0**

Doors: 203

Description: HMD STOREROOM LOCK CLOSER OH GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surf Overhead Stop	10-X36	630	RF	087100
1 Surface Closer	3501	689	YA	087100
1 Gasketing	S88D		PE	087100

**Set: 21.0**

Doors: 177

Description: HMD STOREROOM LOCK CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surface Closer	3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 21.1**

Doors: 120, 125

Description: HMD STOREROOM EXIT PR CLOSER GASKET WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 5" x 4-1/2"	US26D	MK	087100
1 Rim Exit Device, Nightlatch	6100ED PB627F 1109 x 6-Pin GB	630	YA	087100
1 Surface Closer	PR3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 21.2**

Doors: 158

Description: HMD PAIR STOREROOM EXIT PR CLOSER GASKET

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Concealed Vert Rod Exit, Storeroom	6160ED LBR PB626F 1109 x 6-Pin GB	630	YA	087100

1 Concealed Vert Rod Exit, Dummy	6160ED LBR PB629F	630	YA	087100
2 Surface Closer, CPS	3531	689	YA	087100
1 Gasketing	S88D		PE	087100
2 Astragal	305CN (2 pc set)		PE	087100

**Set: 22.0**

Doors: 171

Description: HMD STOREROOM LOCK PR CLOSER WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 5" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surface Closer	PR3501	689	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
3 Silencer	608		RO	087100

**Set: 23.0**

Doors: 129, 174

Description: STOREROOM LOCK CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
3 Silencer	608		RO	087100

Notes: KICKPLATE ONLY AT WOOD DOOR.

**Set: 24.0**

Doors: 158

Description: PAIR HMD CVR EXIT STOREROOM / DMY CPS CLOSER

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Concealed Vert Rod Exit, Storeroom	6160ED LBR PB626F 1109 x 6-Pin GB	630	YA	087100
1 Concealed Vert Rod Exit, Dummy	6160ED LBR PB629F	630	YA	087100
2 Surface Closer, CPS	3531	689	YA	087100
1 Gasketing	S88D		PE	087100
2 Astragal	305CN (2 pc set)		PE	087100

**Set: 25.0**

Doors: 169

Description: PAIR HMD STOREROOM LOCK MFB CPS CLOSER OH STOP

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Dust Proof Strike	570	US26D	RO	087100
2 Flush Bolt	555/557 per dr mtrl	US26D	RO	087100
1 Storeroom or Closet Lock	PB 5405LN GB	626	YA	087100
1 Surf Overhead Stop	10-X36	630	RF	087100
1 Surface Closer, CPS	3531	689	YA	087100
2 Silencer	608		RO	087100

**Set: 26.0**

Doors: 104A, 104B, 105, 106, 107, 108, 109, 110, 111, 112, 126, 127, 128, 133, 135A, 136B, 137, 138, 139, 140, 143, 144, 148, 149, 150, 151, 166, 172, 201

Description: OFFICE LOCK NO CLOSER GASKET

3 Hinge, Full Mortise	TA2714 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Entry Lock	PB 5407LN GB	626	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 27.0**

Doors: 206

Description: WD OFFICE LOCK NO CLOSER OH STOP GASKET

3 Hinge, Full Mortise	TA2714 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Entry Lock	PB 5407LN GB	626	YA	087100
1 Surf Overhead Stop	10-X36	630	RF	087100
1 Gasketing	S88D		PE	087100

**Set: 28.0**

Doors: 119A, 119B, 173A

Description: OFFICE LOCK CPS CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Entry Lock	PB 5407LN GB	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 29.0**

Doors: 173B

Description: OFFICE LOCK CLOSER PH STOP GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Entry Lock	PB 5407LN GB	626	YA	087100
1 Surf Overhead Stop	10-X36	630	RF	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 30.0**

Doors: 180B, 180C

Description: PAIR WD SVR LBR CLASSROOM EXIT CPS CLOSER GASKET

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 NRP FT 4-1/2" x 4-1/2"	US26D	MK	087100
2 Surface Vert Rod Exit, Classroom	6170ED LBR PB626F 1109 x 6-Pin GB	630	YA	087100
2 Surface Closer, CPS	3531	689	YA	087100
2 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Gasketing	S88D		PE	087100
2 Astragal	305CN (2 pc set)		PE	087100

**Set: 31.0**

Doors: 102A, 102B, 135B, 205B

Description: PASSAGE LATCH CLOSER

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
3 Silencer	608		RO	087100

**Set: 32.0**

Doors: 157, 205A

Description: PASSAGE LATCH CPS CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100

1 Gasketing S88D PE 087100

**Set: 33.0**

Doors: 116, 152A

Description: PASSAGE LATCH PR CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer	PR3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 34.0**

Doors: 121

Description: PASSAGE LATCH CPS CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 35.0**

Doors: 160, 161

Description: PASSAGE LATCH CPS CLOSER GASKETS DOOR VIEWER

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
2 Gasketing	S88D Double Row for Sound		PE	087100
1 Frame Protection Pads	ACP112BL		PE	087100
1 Door Bottom, concealed	434APKL		PE	087100
1 Viewer	622	DCRM	RO	087100

**Set: 36.0**

Doors: 141

Description: PASSAGE LATCH CLOSER GASKET WIDE

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 5" x 4-1/2"	US26D	MK	087100
1 Passage Latch	PB 5401LN	626	YA	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100



1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 37.0**

Doors: 155A

Description: PAIR HMD CVR LBR PASSAGE CPS CLOSER

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
2 Concealed Vert Rod Exit, Passage	6160ED LBR PB628F	630	YA	087100
2 Surface Closer, CPS	3531	689	YA	087100
2 Silencer	608		RO	087100

**Set: 38.0**

Doors: 179

Description: PAIR WD PASSAGE LATCH MFB OH STOP

6 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Dust Proof Strike	570	US26D	RO	087100
2 Flush Bolt	555/557 per dr mtrl	US26D	RO	087100
1 Passage Latch	PB 5401LN	626	YA	087100
2 Surf Overhead Stop	10-X36	630	RF	087100
2 Silencer	608		RO	087100

**Set: 39.0**

Doors: 122, 123

Description: PRIVACY LATCH CPS CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Privacy Lock	PB 5402LN	626	YA	087100
1 Surface Closer, CPS	3531	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 40.0**

Doors: 156, 178, 204

Description: PRIVACY LATCH CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Privacy Lock	PB 5402LN	626	YA	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 41.0**

Doors: 162, 163

Description: PRIVACY LATCH NO CLOSER GASKET SWEEP

3 Hinge, Full Mortise, Hvy Wt	T4A3386/T4A4336 FT 4-1/2" x 4-1/2"	US32D	MK	087100
1 Privacy Lock	PB 5402LN	626	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100
1 Sweep	315CN		PE	087100

**Set: 42.0**

Doors: 134

Description: PRIVACY LATCH NO CLOSER

3 Hinge, Full Mortise	TA2714 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Privacy Lock	PB 5402LN	626	YA	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 43.0**

Doors: 103, 115, 117, 181

Description: PUSH/PULL CLOSER GASKET

3 Hinge, Full Mortise, Hvy Wt	T4A3786/T4A4786 FT 4-1/2" x 4-1/2"	US26D	MK	087100
1 Push Plate	70C	US32D	RO	087100
1 Pull Plate	110x70C	US32D	RO	087100
1 Surface Closer	3501	689	YA	087100
1 Kick Plate	K1050 10" x 2" LDW 4BE CSK	US32D	RO	087100
1 Wall Stop	RM861	US32D	RO	087100
1 Gasketing	S88D		PE	087100

**Set: 44.0**

Doors: MISC

Description: MISC

1 BITTING LIST	KEY RECORDS			
1 KEY BLANKS	BOX OF 50			
1 Key Cabinet	Sized per specification documents		LU	
1 Knox Box	Knox Box (coordinate with local fire station for requirements and location)			

Notes: LOCATE KNOX BOX AT ROOM 170.

END OF SECTION 087100

## **SECTION 087113 - AUTOMATIC DOOR OPERATORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Low energy automatic door operators for swinging doors.
- B. Related Sections:
  - 1. Division 01 Section "General Conditions".
  - 2. Division 01 Section "Closeout Procedures".
  - 3. Division 08 Section "Hollow Metal Doors and Frames".
  - 4. Division 08 Section "Flush Wood Doors".
  - 5. Division 08 Section "Door Hardware".
  - 6. Division 26 Section "Electrical".
- A. Codes and Standards: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ANSI/BHMA A156.4 - Door Controls, Door Closers.
  - 3. ANSI/BHMA A156.19 - Power Assist and Low-Energy Power Operated Doors.
  - 4. ICC/IBC - International Building Code.
  - 5. NFPA 70 - National Electrical Code.
  - 6. NFPA 80 - Fire Doors and Windows.
  - 7. NFPA 101 - Life Safety Code.
  - 8. NFPA 105 - Installation of Smoke Door Assemblies.
  - 9. UL/ULC and CSA C22.2 – Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
  - 10. UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.
  - 11. State Building Codes, Local Amendments.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Automatic door operators to be used on interior or exterior doors; up to 200 pounds (91 kg) weight and maximum door width of 48" (1219 mm).
  - 1. Auto door operator capable of operating within temperature ranges of -22°F (-30°C) and 122°F (50°C).

## 1.4 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators, including activation devices. Include operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: Include details and attachments to other work.
  - 1. Include locations and elevations of each unique entrance showing activation devices.
  - 2. Indicate required clearances, components, and location and size of field connections.
  - 3. Wiring Diagrams: For power, signal, and activation wiring.
- C. Qualification Data: Provide copy of manufacturer's official certification or accreditation document indicating proof of status as a qualified and authorized installer of automatic door operators and accessories.
- D. Operating and Maintenance Manuals: Provide manufacturer's operating and maintenance manual for each item comprising the automatic door operator installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturer and Installer providing the operators and installation. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- E. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
- B. Certified Installer Qualifications: Power operator products and accessories are required to be supplied and installed through the Norton Preferred Installer (NPI) program. Suppliers are to be factory trained, certified, and a direct purchaser of the specified power operators and be responsible for the installation and maintenance of the units and accessories indicated for the Project.
- C. Source Limitations: Obtain automatic door operators, including activation devices, from single source, qualified supplier unless otherwise indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- E. Exit Door Requirements: Comply with requirements of authorities having jurisdiction for doors with automatic door operators serving as a component of a required means of egress.
- F. Fire Rated Door Assemblies: Provide operators for fire rated door assemblies that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.

- G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and the procedures for receiving, handling, and installing automatic door operators.
1. Prior to installation of automatic door operators, arrange for certified Installer's representative to conduct a project specific meeting to review the installation and maintenance of their respective products. Project meeting to be attended by representatives of related trades furnishing and installing the aluminum, hollow metal and wood doors sections.
  2. Review and finalize construction schedule and verify availability of materials.

## 1.6 COORDINATION

- A. Electrical Systems Coordination: Coordinate the layout and installation of scheduled automatic door operators and related activation devices, with required connections to source power junction boxes, remote power supplies, access control equipment, detection and monitoring hardware, and fire alarm system.
- B. Templates: Obtain and distribute to the parties involved, templates for doors, frames, operators, and other work specified to be factory prepared and reinforced for installing automatic door operators. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic door operators to comply with indicated requirements.
- C. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified automatic door operators without additional in-field modifications.

## 1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer, agreeing to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period after final acceptance by Owner. Failures include, but are not limited to, the following:
1. Faulty or sporadic operation of automatic door operator, including activation and safety devices.
  2. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
- C. Special Warranty Period: Two years from date of Substantial Completion.
- D. Provide extended warranty from defects in material or workmanship under normal use for a period of 3 years from the date of substantial completion for units installed by a certified

ASSA ABLOY Power Operator Preferred Installer in accordance with the manufacturer's written warranty certificate.

## **1.8 MAINTENANCE SERVICE**

- A. Maintenance Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance by skilled employees of automatic door operator Installer. Include planned and preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.
- B. Extended Maintenance Support and Service Agreement: Submit for Owner's consideration an optional extended Service Agreement for the installed automatic door operator system. The extended Service Agreement is considered elective and is without manufacturer's requirement stipulating mandatory coverage for owner and/or vendor system support.
  - 1. A published copy of this agreement to be included with the submittal package
  - 2. Support for the installed automatic door operator system is provided through the vendor under a specified, limited 24 hour support program.
  - 3. Automatic door operators and components are to be available on a one-day turn around time frame from the vendor.

## **PART 2 - PRODUCTS**

### **2.1 ELECTROHYDRAULIC DOOR OPERATORS**

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
  - 1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:
  - 1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
  - 2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing

cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. LCN Closers (LC) - 4640 Series.
  2. Norton Door Controls (NO) - 6000 Series.
  3. Stanley Security Solutions (ST) – D-4990 Series.

## 2.2 ACTIVATION DEVICES

- A. General: Provide activation devices in accordance with ANSI/BHMA A156.19 standard, for condition of exposure indicated and for long term, maintenance free operation under normal traffic load operation. Coordinate activation control with electrified hardware and access control interfaces. Activation switches are standard SPST, with optional DPDT availability.
- B. Push-Plate Switch: Momentary contact door control switch with push-plate actuator.
  1. Configuration: Square or round push-plate control switch with single or double gang junction box mounting. Provide narrow profile face plate where indicated for jamb or mullion mounting.
    - a. Mounting Location: As indicated on Drawings.
  2. Push-Plate Material: Stainless steel.
  3. Message: International symbol of accessibility with "Push (Press) to Open (Operate)" text.
  4. Manufacturers:
    - a. BEA Sensors (BS) – PBS45 Series.
    - b. Norton Door Controls (NO) – 500 Series.
    - c. Wikk Industries (WI) – 4x4 Series.
- C. Touch Less Wall Switch: Momentary contact door control switch with movement required activation. Single or double gang box junction box mounting.
  1. Doppler radar sensor.
  2. Mounting Location: As indicated on Drawings.



3. Manufacturers:
  - a. BEA Sensors (BS) – MS Series.
  - b. Norton Door Controls (NO) – 700 Series.
  - c. Securitron (SU) – WSS Series.

### **2.3 ACCESSORIES**

- A. Signage: As required by cited ANSI/BHMA A156.19 standard for the type of operator.

### **2.4 FINISHES**

- A. Standard: Designations used to indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware. Units will be sprayed with a combination of waterborne acrylic and polyester powder coat.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

### **2.5 OPENING LABELS**

- A. Provide 1"W x 2"H gloss polyester label imprinted with door mark and QR-type code readable via IR and visible light scan. QR code links to a security credential protected site displaying the installed door opening information. Label constructed with a high-performance, permanent acrylic adhesive resistant to chemicals, smear and scratch, and repeated freeze and thaw cycles. Face stock of label to be white or clear coated, 2.0 mil thickness with tensile strength meeting or exceeding 18,000 psi.
  1. Approved Manufacturer: Openings Studio™ Smart Tags (AA).

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, power connections, electrical systems interfaces, and other conditions affecting performance of automatic door operators.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

### **3.2 INSTALLATION**

- A. General: Install complete automatic door operators according to manufacturer's written instructions and ANSI/BHMA A156.19 standard, including activation devices, control wiring, remote power units if any, connection to the building's fire alarm system, and required signage.
- B. Power Connection: Reference Division 26 "Electrical" Sections for connection to electrical power distribution system.
- C. Access Control System: Coordinate connections and operation with access control system
- D. Signage: Apply signage as required by ANSI/BHMA A156.19 standard for type of door operator and direction of pedestrian travel.

### **3.3 FIELD QUALITY CONTROL**

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
  - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
  - 2. Submit documentation of incomplete items in the following formats:
    - a. PDF electronic file.
    - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

### **3.4 ADJUSTING**

- A. Comply with requirements of ANSI/BHMA A156.19 standard. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer.

### **3.5 DEMONSTRATION**

- A. Certified Installer's representative to provide eight (8) hours of training to Owner's maintenance personnel in the proper adjustment, operation, and maintenance of automatic door operators.

END OF SECTION 087113

**SECTION 088000 - GLAZING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes:
  - 1. Glass for windows, doors, interior borrowed lites.
  - 2. Glazing sealants, acoustical sound gaskets and accessories.
- B. Related Requirements:
  - 1. Section 084113 "Aluminum Framed Entrances and Storefronts"
  - 2. Section 084413 "Glazed Aluminum Curtain Walls"
  - 3. Section 085653 "Security Windows".

**1.3 DEFINITIONS**

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

**1.4 COORDINATION**

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

**1.5 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project Site
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review temporary protection requirements for glazing during and after installation.

**1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of product.
  - 1. Insulating glass.
- C. Glazing Accessory Samples: For sealants, acoustical sound gaskets and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### **1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturers of insulating-glass units with sputter-coated, low-E coatings.
- B. Product Certificates: For glass.
- C. Product Test Reports: For insulating glass and glazing sealants, for tests performed by a qualified testing agency.
  - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Product data for each patterned glass film, including:
  - 1. preparation instructions and recommendations
  - 2. Storage and handling requirements and recommendations
  - 3. Installation methods.
- F. Sample Warranties: For special warranties.

### **1.8 QUALITY ASSURANCE**

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

### **1.9 PRECONSTRUCTION TESTING**

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
  - 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
  - 2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
  - 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  - 4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
  - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

### **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

### **1.11 FIELD CONDITIONS**

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
  - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

### **1.12 WARRANTY**

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
  - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
  - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
  - 1. Warranty Period: 10 years from date of Substantial Completion.
- D. Manufacturer's Special Warranty for Patterned Glass Film: Manufacturer standard limited warranty against manufacturing defect, outlining terms, conditions and exclusions from coverage. Installer warranty for 2 years from date of Substantial Completion covering installation defects including, but not limited to, bubbling, peeling, fading, and delamination.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers
  - 1. **(GL-1, GL-2):**

- a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - 1) Vitro Industries
  - b. Acceptable Manufacturers:
    - 1) AGC
    - 2) Guardian
    - 3) Viracon
2. **GL-5 (One-Way Transparent Mirror)**
- a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - 1) Viracon
      - a) 9/16" (14mm) Laminated VS3-08; 1/4" (6mm) gray with VS-08 #2; .060" (1.52mm) clear PVB; 1/4" (6mm) clear
  - b. Acceptable Manufacturers:
    - 1) Pilkington Mirropane.
    - 2) AIS.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- D. Substitutions: If glazing is proposed that differs from specific products and manufacturers listed in the schedule, samples must be submitted 10 days prior to bid for review and approval.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
  - 1. Design Wind Pressures: As indicated on Drawings.
  - 2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
    - a. Wind Design Data: As indicated on Drawings.
    - b. Basic Wind Speed: 100 mph.
    - c. Importance Factor: 1.0.
    - d. Exposure Category: C.
  - 3. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
  - 4. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

5. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
  6. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick unless otherwise indicated.
  2. For laminated-glass lites, properties are based on products of construction indicated.
  3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
  4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
  5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
  6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

### 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
  2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
  3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
  4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass. Where fully tempered float glass is indicated, provide fully tempered float glass.

### 2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Ultraclear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.

- C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
  - 2. Fabrication Tolerances:
    - a. 50 percent of the requirements of ASTM C 1048 for localized warp and overall bow and warp.
    - b. Roll wave or ripple: The deviation from flatness at any peak shall not exceed .005 inch and the difference between adjacent peaks shall not exceed .003 inch, except within 10-1/2" of the leading or trailing edge where deviation from flatness shall not exceed .008" peak to valley.
    - c. Where fabrication tolerances conflict, the stricter requirement shall govern.
    - d. Glass manufacturer/fabricator shall verify that production for this Project meets these conditions.
- E. Pyrolytic-Coated, Low-Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

## 2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
  - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
  - 2. Perimeter Spacer: Aluminum with black, color anodic finish.
  - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.6 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
  - 4. Colors of Exposed Glazing Sealants As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
  - 1. As recommended by window manufacturer



## 2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
  - 1. AAMA 804.3 tape, where indicated.
  - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
  - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks:
  - 1. EPDM or Neoprene with a Shore A durometer hardness of 85, plus or minus 5.
  - 2. Type recommended by sealant or glass manufacturer.
- D. Spacers:
  - 1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
  - 2. Type recommended by sealant or glass manufacturer.
- E. Edge Blocks:
  - 1. EPDM or Neoprene with a Shore A durometer hardness per manufacturer's written instructions.
  - 2. Type recommended by sealant or glass manufacturer.
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

## 2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
  - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
    - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep systems.
  - 3. Minimum required face and edge clearances.
  - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

#### **3.3 GLAZING, GENERAL**

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### **3.4 TAPE GLAZING**

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

### **3.5 GASKET GLAZING (DRY)**

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

### 3.8 INSULATING GLASS SCHEDULE

- A. Glass Type **(GL-1)**: Low-E-coated Clear insulating glass.
  - 1. Basis-of-Design Product: Vitro; Solarban 60 (2) Optigray.
    - a. Guardian, SNX51/23 or AGC Energy Select 23
  - 2. Overall Unit Thickness: 1 inch
  - 3. Minimum Thickness of Each Glass Lite: 6 mm
  - 4. Outdoor Lite: Clear Heat-strengthened float glass.
  - 5. Interspace Content: Argon
  - 6. Indoor Lite: Clear fully tempered float glass
  - 7. SHGC: .30 maximum
  - 8. Visible Light Transmittance: 50%.
  - 9. Winter Nighttime U-Factor: 0.24 maximum.
  - 10. Light to Solar Gain: 1.67
  - 11. Safety glazing required.
- B. Glass Type **(GL-2)**: Low-E-coated Tinted insulating glass.
  - 1. Basis-of-Design Product: Vitro; Solarban 60 (3) Optigray.
    - a. Guardian, SNX51/23 or AGC Energy Select 23
  - 2. Overall Unit Thickness: 1 inch
  - 3. Minimum Thickness of Each Glass Lite: 6 mm
  - 4. Outdoor Lite: Clear Heat-strengthened float glass.
  - 5. Interspace Content: Argon
  - 6. Indoor Lite: Clear fully tempered float glass
  - 7. SHGC: .30 maximum
  - 8. Visible Light Transmittance: 50%.
  - 9. Winter Nighttime U-Factor: 0.24 maximum.

10. Light to Solar Gain: 1.67
11. Safety glazing required.

### **3.9 MONOLITHIC GLASS SCHEDULE**

- A. Glass Type **(GL-3)**: Clear float glass.
  1. Minimum Thickness: 1/4" unless otherwise noted.
  2. Safety glazing required.
- B. Glass Type **(GL-4)**: Clear fully tempered float glass.
  1. Minimum Thickness: 1/4" unless otherwise noted.
  2. Safety glazing required.
- C. Glass Type **(GL-5)**: 1/2" Laminated Safety Glass with mirrored, one-way coating.

### **3.10 SECURITY WINDOW GLASS SCHEDULE**

- A. Glass Type **(GL-6, GL-7, GL-8)**: Interior bullet resisting barriers with baffles. Refer to Section 085653 "Security Windows".

END OF SECTION 088000

**SECTION 088300 - MIRRORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes the following types of silvered flat glass mirrors:
  - 1. Annealed monolithic glass mirrors.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of mirror and mirror mastic.
- C. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.
- D. Sample Warranty: For special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For mirrors to include in maintenance manuals.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

**1.8 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
  1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- B. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

### 2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.
- B. Annealed Monolithic Glass Mirrors: Mirror Glazing Quality, ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.
  1. Nominal Thickness: 5.0 mm.

### 2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

### 2.4 FABRICATION

- A. Fabricate mirrors in the shop to greatest extent possible.
- B. Mirror Edge Treatment: Flat polished.
  1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
  2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.

- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

### **3.2 PREPARATION**

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

### **3.3 INSTALLATION**

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Install mirrors with mastic. Retain subparagraph below if mirrors are to be installed with mastic.
  - 1. Install mastic as follows:
    - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
    - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
    - c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

### **3.4 CLEANING AND PROTECTION**

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300



**SECTION 092216 - NON-STRUCTURAL METAL FRAMING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior partitions.
  - 2. Suspension systems for interior ceilings and soffits.
  - 3. Grid suspension systems for gypsum board ceilings.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed, high-strength steel studs and tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

**2.2 FRAMING SYSTEMS**

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
  - 2. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- C. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
  - 1. Steel Studs and Tracks:
    - a. Minimum Base-Metal Thickness: .023 unless otherwise indicated on the drawings.
    - b. Depth: As indicated on Drawings

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.
  - a. Minimum Base-Metal Thickness: .025 inch unless otherwise indicated on the drawings and equivalent in strength to non-dimpled steel studs.
  - b. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide one the following:
  1. Single Long-Leg Track System: ASTM C645 top track with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
  3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  1. Minimum Base-Metal Thickness: 0.027 inch unless otherwise indicated on the drawings.
- G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
  1. Depth: 1-1/2 inches unless otherwise indicated on the drawings.
  2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  1. Minimum Base-Metal Thickness: 0.033 inch unless otherwise indicated on the drawings.
  2. Depth: 7/8 inch unless otherwise indicated on the drawings.
- I. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
  1. Configuration: Asymmetrical.
- J. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
  1. Depth: 3/4 inch unless otherwise indicated.
  2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
  3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

### 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
    - a. Type: Postinstalled, expansion anchor.
  2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- A. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
  - B. Flat Hangers: Steel sheet, 1 by 3/16 inch.
  - C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges.
    1. Depth: 1-1/2 inches unless otherwise indicated on the drawings.
  - D. Furring Channels (Furring Members):
    1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
    2. Steel Studs and Runners: ASTM C 645.
      - a. Minimum Base-Metal Thickness: 0.027 inch unless otherwise indicated on the drawings.
      - b. Depth: As indicated on Drawings.
    3. Dimpled Steel Studs and Runners: ASTM C 645.
      - a. Minimum Base-Metal Thickness: 0.025 inch unless otherwise indicated on the drawings
      - b. Depth: As indicated on Drawings.
    4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
      - a. Minimum Base-Metal Thickness: 0.018 inch unless otherwise indicated on the drawings
    5. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
      - a. Configuration: Asymmetrical.
  - E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
    1. Manufacturers:
      - a. Basis of design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
        - 1) US Gypsum Company
      - b. Acceptable Manufacturers:
        - 1) Armstrong
        - 2) CertainTeed

## 2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
  1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
  1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### **3.3 INSTALLATION, GENERAL**

- A. Installation Standard: ASTM C754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### **3.4 INSTALLING FRAMED ASSEMBLIES**

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 24 inches o.c. unless otherwise indicated.
  - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.

- b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
  - 6. Curved Partitions:
    - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
  - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:
  - 1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
  - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
  - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### 3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Hangers: 48 inches o.c.
  - 2. Carrying Channels (Main Runners): 48 inches o.c.
  - 3. Furring Channels (Furring Members): 24 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard

suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel roof deck.
  6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

**SECTION 092400 - CEMENT PLASTERING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Exterior horizontal and nonvertical plasterwork (stucco).
  - 2. Soffit vents.

**1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples: For each type of factory-prepared finish coat and for each color and texture specified.
- D. Samples for Initial Selection: For each type of factory-prepared finish coat and for each color and texture specified.
- E. Samples for Verification: For each type of factory-prepared finish coat and for each color and texture specified, 12 by 12 inches, and prepared on rigid backing.

**1.5 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build mockups for each substrate and finish texture indicated for cement plastering, including accessories.
    - a. Size: 100 sq. ft. in surface area.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover, and keep them dry and protected against damage from weather, moisture, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

## 1.7 FIELD CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Exterior Plasterwork:
  1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
  2. Apply plaster when ambient temperature is greater than 40 deg F.
  3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide cement plaster assemblies identical to those of assemblies tested for fire resistance according to ASTM E 119 by a qualified testing agency.

### 2.2 METAL LATH

- A. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet with ASTM A 653/A 653M, G60, hot-dip galvanized-zinc coating.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. CEMCO; California Expanded Metal Products Co.
  2. Acceptable Manufacturers:
    - a. ClarkDietrich Building Systems
    - b. Phillips Manufacturing Co.
  3. Diamond-Mesh Lath: Flat, 2.5 lb/sq. yd.
  4. 3/8-Inch Rib Lath.
- B. Wire-Fabric Lath:



1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Davis Wire; a Heico Wire Group company.
  2. Acceptable Manufacturers:
    - a. Jaenson Wire Company.
    - b. Keystone Steel & Wire Co.
  3. Woven-Wire Lath: ASTM C 1032; self-furring, with stiffener wire backing, 1.4 lb/sq. yd.
- C. Paper Backing: FS UU-B-790a, Type I, Grade B, Style 1a vapor-retardant paper.

### 2.3 ACCESSORIES

- A. General: Comply with ASTM C 1063, and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Metal Accessories:
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. CEMCO; California Expanded Metal Products Co.
  2. Acceptable Manufacturers:
    - a. ClarkDietrich Building Systems
    - b. Phillips Manufacturing Co.
  3. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 zinc coating.
  4. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized-zinc coating.
  5. External- (Outside-) Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized-zinc coating.
  6. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.
    - a. Smallnose cornerbead with expanded flanges; use unless otherwise indicated.
    - b. Smallnose cornerbead with perforated flanges; use on curved corners.
    - c. Smallnose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
    - d. Bullnose cornerbead, radius 3/4 inch minimum, with expanded flanges; use at locations indicated on Drawings.
  7. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
  8. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
  9. Expansion Joints: Fabricated from zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.

### 2.4 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in cement plaster.
- C. Bonding Compound: ASTM C 932.
- D. Fasteners for Attaching Metal Lath to Substrates: ASTM C 1063.
- E. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter unless otherwise indicated.

## **2.5 PLASTER MATERIALS**

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type II.
- B. Plastic Cement: ASTM C 1328.
- C. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color to match Architect's sample.
- D. Sand Aggregate: ASTM C 897.
  - 1. Color for Job-Mixed Finish Coats: White.
- E. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems formulated with colorfast mineral pigments and fine aggregates; for use over cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Sto Corp.
  - 2. Acceptable Manufacturers:
    - a. Senergy, BASF Corp.
    - b. Superwall Stucco System.
  - 3. Color: Match Architect's sample.

## **2.6 PLASTER MIXES**

- A. General: Comply with ASTM C926 for applications indicated.
  - 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
  - 1. Portland Cement Mixes:
    - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.

- b. Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
  - 2. Masonry Cement Mixes:
    - a. Scratch Coat: Mix 1 part masonry cement and 2-1/2 to 4 parts aggregate.
    - b. Brown Coat: Mix 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
  - 3. Portland and Masonry Cement Mixes:
    - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - b. Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
  - 4. Plastic Cement Mixes:
    - a. Scratch Coat: Mix 1 part plastic cement and 2-1/2 to 4 parts aggregate.
    - b. Brown Coat: Mix 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
  - 5. Portland and Plastic Cement Mixes:
    - a. Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
    - b. Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
- C. Job-Mixed Finish-Coat Mixes:
- 1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
  - 2. Masonry Cement Mix: Use 1 part masonry cement and 1-1/2 to 3 parts aggregate.
  - 3. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
- D. Primer--mix with a clean, rust-free high speed mixer to a uniform consistency.
- E. Finish--mix with a clean, rust-free high speed mixer to a uniform consistency. A small amount of water may be added to adjust workability. Limit addition of water to amount needed to achieve the finish texture.
- F. Mix only as much material as can readily be used.
- G. Do not use anti-freeze compounds or other additives.

**2.7 SOFFIT VENTS**

- A. Aluminum: Extruded alloy 6063 TS with clear anodized finish.
- B. Acceptable Manufacturer: Fry Reglet.

**2.8 ADDITIONAL MATERIALS**

- A. Wall Underlayment:
  - 1. Grade D Kraft waterproof building paper, UBC Standard No. 14-1.
  - 2. Asphalt Saturated Felt meeting or exceeding the requirements of ASTM D 226 Type I.
  - 3. Weather Resistant Barrier meeting the requirements of ICC-ES AC-38.
  - 4. Water Resistive barrier meeting the requirements of ASTM E 2556/E 2556M.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
- B. Prepare smooth, solid substrates for plaster according to ASTM C 926.

**3.3 INSTALLATION, GENERAL**

- A. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.

**3.4 INSTALLING METAL LATH**

- A. Metal Lath: Install according to ASTM C 1063.
  - 1. Partition Framing and Vertical Furring: Install woven-wire lath.
  - 2. Flat-Ceiling and Horizontal Framing: Install 3/8-inch rib lath.
  - 3. On Solid Surfaces, Not Otherwise Furred: Install self-furring, woven-wire lath.

**3.5 INSTALLING ACCESSORIES**

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.

- B. Reinforcement for External (Outside) Corners:
  1. Install lath-type, external-corner reinforcement or cornerbead at exterior locations.
  2. Install cornerbead at interior locations.
- C. Control Joints: Locate as approved by Architect for visual effect and as follows:
  1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
    - a. Vertical Surfaces: 144 sq. ft.
    - b. Horizontal and Other Nonvertical Surfaces: 100 sq. ft.
  2. At distances between control joints of not greater than 18 feet o.c.
  3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
  4. Where control joints occur in surface of construction directly behind plaster.
  5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

### 3.6 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
  1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces when measured by a 10-foot straightedge placed on surface.
  2. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
  3. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Bonding Compound: Apply on unit masonry substrates for direct application of plaster.
- C. Walls; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having 3/8-inch thickness on masonry, as follows:
  1. Portland cement mix.
  2. Masonry cement mix.
  3. Portland and masonry cement mix.
  4. Plastic cement mix.
  5. Portland and plastic cement mix.
- D. Ceilings; Base-Coat Mix: For base (scratch) coat, for two-coat plasterwork and having 1/4-inch thickness on concrete, as follows:
  1. Portland cement mix.
  2. Masonry cement mix.
  3. Portland and masonry cement mix.
  4. Plastic cement mix.
  5. Portland and plastic cement mix.
- E. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
- F. Concealed Exterior Plasterwork: Where plaster application is used as a base for adhered finishes, omit finish coat.

**3.7 PLASTER REPAIRS**

- A. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

**3.8 CLEANING AND PROTECTION**

- A. Remove temporary protection and enclosure of other work after plastering is complete. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 092400

## **SECTION 092900 - GYPSUM BOARD ASSEMBLIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior gypsum board.
  - 2. Tile backing panels.
  - 3. Bullet-Resistant panels.
  - 4. Reglets and Reveals
- B. Related Requirements:
  - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### **1.5 FIELD CONDITIONS**

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

## 2.2 INTERIOR GYPSUM BOARD

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
1. United States Gypsum Company
- B. Acceptable Manufacturers:
- a. American Gypsum
  - b. Certainteed Corporation
  - c. National Gypsum Company
  - d. Temple-Inland Building Products
- C. Gypsum Wallboard: ASTM C1396/C1396M.
1. Thickness: 5/8 inch, unless otherwise noted.
  2. Long Edges: Tapered.
- D. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Thickness: 5/8 inch.
  2. Long Edges: Tapered.
- E. Gypsum Ceiling Board: ASTM C1396/C1396M.
1. Thickness: 1/2 inch.
  2. Long Edges: Tapered.
- F. Abuse-Resistant Type X Gypsum Panel: ASTM C1396.
1. Thickness: 5/8 inch.
  2. Long Edges: Tapered
  3. Abuse Resistance: ASTM C1629.
- G. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces. For exterior walls and wet walls (shower rooms, toilets, janitor closets, etc), and as noted in the drawings.
1. Core: 5/8 inch, Type X.
  2. Long Edges: Tapered.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- H. Moisture- and Mold-Resistant Glass Mat Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and glass mat surfaces. For exterior walls, and as noted in the drawings.
1. Core: 5/8 inch, Type X.
  2. Long Edges: Tapered.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
  4. Follow manufacturer recommendations for skim coat of entire panel surface. Reference ASTM C840 for finishing.

## 2.3 WALL SHEATHING

- A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
1. Type and Thickness: Fiberglass mat gypsum sheathing, Type X, 5/8 inch thick unless otherwise noted.
  2. Size: 48 by 96 inches or 48 by 120 inches for vertical installation.
  3. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Georgia Pacific DensGlass



4. Acceptable Manufacturers:
  - a. USG Securock
  - b. Certainteed GlasRoc

## 2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
  1. Core: 1/2 inch, regular type 5/8 inch, Type X.
  2. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
  1. Thickness: 5/8 inch.
  2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

## 2.5 BULLET-RESISTANT PANELS

- A. Bullet-Resistant Fiberglass Panels shall be "non ricochet type" to permit the encapture and retention of an attacking projectile lessening the potential of a random injury or lateral penetration.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. ArmorCore UL 572 Level 2
  2. Acceptable Manufacturers:
    - a. Armortex
    - b. Fortified Estate
- B. Panel Rating: UL752 Level 2.
- C. Bullet-Resistance of joints: equal to that of the panel.

## 2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  2. Shapes:
    - a. Cornerbead.
    - b. Bullnose bead.
    - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - d. L-Bead: L-shaped; exposed long flange receives joint compound.
    - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    - f. Expansion (control) joint.
- B. Exterior Trim: ASTM C 1047.
  1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
  2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

- C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Fry Reglet, DRM-625-50.
  - 2. Acceptable Manufacturers:
    - a. Gordon Incorporated.
    - b. Pittcon Industries.
  - 3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221 (ASTM B221M), Alloy 6063-T5.
  - 4. Finish: Clear anodized.

## 2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
  - 2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
  - 3. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
  - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
  - 5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Tile Backing Panels:
  - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

## 2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
  - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
  - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- E. Vapor Retarder: As specified in Section 072100 "Thermal Insulation."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLYING AND FINISHING PANELS, GENERAL**

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  - 1. Wallboard Type: Vertical surfaces unless otherwise indicated.
  - 2. Type X: Where required for fire-resistance-rated assembly.
  - 3. Ceiling Type: Ceiling surfaces.
  - 4. Moisture- and Mold-Resistant Type: As indicated on Drawings and at any interior face of exterior walls.
  - 5. Glass-Mat Interior Type: As indicated on Drawings- Wet walls to receive tile.
- B. Single-Layer Application:
  - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
  - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
  - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
  - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
  - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
  - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
  - 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

### 3.4 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.5 INSTALLING AND APPLYING BULLET-RESISTANT PANELS

- A. Reinforce joints with a back-up layer of bullet resistive material. Minimum width of reinforcing layer at joint shall be 4-inches, centered on panel joint.
- B. Install armor in accordance with manufacturer's recommendations and as required by contract documents.

- C. Secure armor panels using screws, bolts, or an industrial adhesive.
  1. Method of application shall install panels minimizing vulnerabilities by fitting tightly to adjacent surfaces including concrete floor slab, concrete roof slab, bullet-resistive door frames, bullet-resistive window frames, and the like.

### **3.6 INSTALLING TRIM ACCESSORIES**

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners.
  2. Bullnose Bead: Use where indicated.
  3. LC-Bead: Use at exposed panel edges.
  4. U-Bead: Use where indicated.
- D. Exterior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners.
  2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

### **3.7 FINISHING GYPSUM BOARD**

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  2. Level 2: Panels that are substrate for tile.
  3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
  4. Level 5: Atrium, Pre-function, and any walls indicated on drawings.
    - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

**3.8 PROTECTION**

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

**SECTION 093000 - TILING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  1. Ceramic tile.
  2. Porcelain tile.
- B. Related Sections:
  1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
  2. Section 092900 "Gypsum Board" for glass-mat, water-resistant backer board or cement board.

**1.3 DEFINITIONS**

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

**1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
  1. Full-size units of each type, size and composition of tile and for each color and finish required.
  2. Full-size units of each type of trim and accessory.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Material Test Reports: For each tile-setting and -grouting product.

**1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
  - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

**1.8 QUALITY ASSURANCE**

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.
  - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
  - 1. Crack isolation membrane.
  - 2. Joint sealants.
  - 3. Metal edge strips.

**1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

**1.10 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

**PART 2 - PRODUCTS****2.1 PRODUCTS, GENERAL**

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.



- C. **Factory Blending:** For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. **Factory-Applied Temporary Protective Coating:** Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

## 2.2 TILE PRODUCTS

- A. **Porcelain Tile-1 (T-1)**
  - 1. Floor Tiling: ANSI A137.1, porcelain, impervious (absorption less than 0.5 percent.)
    - a. Trim Shapes: As required of same type, size, thickness and material as tiling.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Daltile, Style: Articulo, Color: Editorial White AR06, Size: 12" X 24"
  - 3. Acceptable Comparable Products:
    - a. Manufacturer: Portobello America, Collection: Filo Glazed Porcelain, Color: Bianco, Size: 12" X 24"
    - b. Manufacturer: Virginia Tile, Collection: CTI Directions, Color: Classic, Size: 12" X 24" Matte
- B. **Porcelain Tile-2 (T-2)**
  - 1. Floor Tiling: ANSI A137.1, porcelain, impervious (absorption less than 0.5 percent.)
    - a. Trim Shapes: As required of same type, size, thickness and material as tiling.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Daltile, Style: Articulo, Color: Feature Beige AR07, Size: 12" X 24"
  - 3. Acceptable Comparable Products:
    - a. Manufacturer: Portobello America, Collection: Filo Glazed Porcelain, Color: Beige, Size: 12" X 24"
    - b. Manufacturer: Virginia Tile, Collection: CTI Directions, Color: Cream, Size: 12" X 24" Matte
- C. **Porcelain Tile-3 (T-3)**
  - 1. Floor Tiling: ANSI A137.1, porcelain, impervious (absorption less than 0.5 percent.)
    - a. Trim Shapes: As required of same type, size, thickness and material as tiling.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Daltile, Style: Archaia, Color: Relic White AR40, Size: 12" X 24"
  - 3. Acceptable Comparable Products:
    - a. Manufacturer: Florida Tile, Collection: Gravitate, Color: GVT10 White, Size: 12" X 24"
    - b. Manufacturer: Atlas Concorde USA, Collection: Exist, Color: Pure, Size: 12" X 24"
- D. **Wall Tile -1 (WT-1)**
  - 1. Glazed Ceramic Wall Tiling: ANSI A137.1, cushion edged, non-vitaceous body, 5/16 inch thick.
    - a. Trim Shapes: As required of same type, size, thickness and material as wall tiling.
  - 2. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:

- a. Manufacturer: Daltile, Series: Color Wheel Classic, Color: Galaxy 1469, Size: 3" X 6"
- 3. Acceptable Comparable Products:
  - a. Manufacturer: Florida Tile, Collection: Emotive, Style: Glossy, Color: Pride Blue, Size: 3" X 12"
  - b. Manufacturer: American Olean, Collection: Color Story Wall, Color: Sapphire Sky 0070, Size: 3" X 6"

### 2.3 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
  - 1. Manufacturers:
    - a. Basis of design: Products selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) MAPEI Corporation
    - b. Acceptable Manufacturers:
      - 1) Bonsal American; an Oldcastle company.
      - 2) Bostik, Inc.
      - 3) C-Cure.
      - 4) Laticrete International, Inc.
      - 5) Custom Building Products
      - 6) Mer-Kote Products, Inc.
      - 7) TEC; a subsidiary of H. B. Fuller Company.
  - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
  - 3. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
  - 4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

### 2.4 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Polymer-Modified Tile Grout: ANSI A118.7.
  - 1. Manufacturers:
    - a. Basis of design: Products selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) MAPEI Corporation
    - b. Acceptable Manufacturers:
      - 1) Bonsal American; an Oldcastle company.
      - 2) Bostik, Inc.
      - 3) C-Cure.
      - 4) Laticrete International, Inc.
      - 5) Custom Building Products
      - 6) TEC; a subsidiary of H. B. Fuller Company.
  - 2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
  - 3. Polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.

## 2.5 ELASTOMERIC SEALANTS

- A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 079200 "Joint Sealants."
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
  - 1. Products:
    - a. Basis of design: Products selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Dow Corning Corporation; Dow Corning 786.
    - b. Acceptable Manufacturers:
      - 1) GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
      - 2) Laticrete International, Inc.; Latasil Tile & Stone Sealant.
      - 3) Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
      - 4) Tremco Incorporated; Tremsil 600 White.

## 2.6 MISCELLANEOUS MATERIALS

- A. Metal cove and outside corners:
  - 1. Provide Schluter Rondec-CT for outside corners.
  - 2. Provide Schluter Rondec-DB for tile / drywall transitions.
    - a. Finish: Matte Black
- B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- C. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
  - 1. Basis of design: Products selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. MAPEI Corporation; KER [004, Keraseal Penetrating Sealer for Unglazed Grout and Tile].
  - 2. Acceptable Manufacturers:
    - a. Bostik, Inc.; CeramaSeal [Silox 8] [Siloxane 220].
    - b. C-Cure; Penetrating Sealer 978.
    - c. Custom Building Products; [Surfaceguard] [Grout and Tile] Sealer.
    - d. Jamo Inc.; Penetrating Sealer.
    - e. Bonsal American; an Oldcastle company; Grout Sealer.
    - f. TEC; a subsidiary of H. B. Fuller Company; TA-256 Penetrating Silicone Grout Sealer.
  - 3. Color: 93 Warm Gray (T-1, T-2, T-3); Black (WT-1)

## 2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.

- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
  1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
  3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 TILE INSTALLATION**

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
  1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
  1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
  2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
  3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
  1. Tile: 1/8 inch.

- G. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
  - 3. Follow TCNA EJ171.
- H. Grout Sealer: Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

### **3.3 CLEANING AND PROTECTING**

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove grout residue from tile as soon as possible.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water after cleaning.
- B. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile.

### **3.4 TILE INSTALLATION SCHEDULE**

- A. As Scheduled on Drawings.
- B. Wall Installations Schedule:
  - 1. Thin Bed Dry Set Mortar: ANSI A108.5.
    - a. Tile backing panels.
  - 2. Grout: Latex-portland cement unless otherwise indicated.

END OF SECTION 093000

## **SECTION 095113 - ACOUSTICAL CEILINGS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes acoustical panels and suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each ceiling tile.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Suspended ceiling components.
  2. Structural members to which suspension systems will be attached.
  3. Size and location of initial access modules for acoustical panels.
  4. Items penetrating finished ceiling including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system, from ICC-ES.
- D. Field quality-control reports.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For finishes to include in maintenance manuals.

#### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Acoustical Ceiling Units: Full-size panels equal to 3 percent of quantity installed.
  2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

**1.9 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained for a minimum of four days at the levels indicated for Project when occupied for its intended use.
  - 1. Pressurized Plenums: Operate ventilation system for not less than 96 hours before beginning acoustical panel ceiling installation.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

**2.2 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Class A according to ASTM E1264.
  - 2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

**2.3 ACOUSTICAL PANELS**

- A. Acoustical Ceiling Tile-1 (**ACT-1**)
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Armstrong World Industries
  - 2. Acceptable Manufacturers:
    - a. USG
    - b. CertainTeed
  - 3. Style: Ultima Beveled Tegular
  - 4. Grid: 9/16" Superfine XL
  - 5. Color: White
  - 6. Size: 24" x 24"

- B. Acoustical Ceiling Tile-2 (**ACT-2**)
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Armstrong World Industries
  - 2. Acceptable Manufacturers:
    - a. USG
    - b. CertainTeed
  - 3. Style: Ultima Beveled Tegular
  - 4. Grid: 9/16" Superfine XL
  - 5. Color: White
  - 6. Size: 24" x 48"
- C. Source Limitations:
  - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
  - 2. Suspension System: Obtain each type from single source from single manufacturer.
- D. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- E. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- F. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
  - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- G. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

## 2.4 METAL SUSPENSION SYSTEM

- A. Basis of Design: Product selections as indicated in the Drawings are based upon the primary manufacturer desired, but is not limited to that listed.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
- C. Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.



## 2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  - 1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  - 2. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
  - 3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
  - 4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

## 2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - 1. Armstrong World Industries
- B. Acceptable Manufacturers:
  - 1. Certainteed Corporation
  - 2. USG
- C. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
  - 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
  - 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

## 2.7 ACOUSTICAL SEALANT

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - 1. Acoustical Sealant for Exposed and Concealed Joints:
    - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
  - 2. Acoustical Sealant for Concealed Joints:
    - a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.

- B. Acceptable Manufacturers:
  - 1. Acoustical Sealant for Exposed and Concealed Joints:
    - a. USG Corporation; SHEETROCK Acoustical Sealant.
    - b. Titebond; Acoustical Smoke & Sound Sealant - FF1021
  - 2. Acoustical Sealant for Concealed Joints:
    - a. Pecora Corporation; AIS-919.
    - b. Tremco, Inc.; Tremco Acoustical Sealant.
- C. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
  - 2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
  - 3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

#### **3.3 INSTALLATION**

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye

- screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. Arrange directionally patterned acoustical panels as follows:
    - a. As indicated on reflected ceiling plans.
  2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
  5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

### 3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

**3.5 CLEANING**

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

## **SECTION 096513 - RESILIENT BASE AND ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Resilient base.
  2. Resilient molding accessories.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Furnish not less than three percent of each type, color, pattern, and size of resilient product installed.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

#### **1.6 FIELD CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
  1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

### **PART 2 - PRODUCTS**

#### **2.1 VINYL BASE**

- A. Rubber Base (**B-1**)
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:

Product Standard: ASTM F386, Type TV (traditional vinyl).

Manufacturer: Tarkett, Style: Traditional Toeless, Color: 63 Burnt Umber, Height: 4", Lengths: Coils in manufacturer's standard length, Outside and Inside Corners: Job formed or preformed.

2. Acceptable Manufacturers:
  - a. Armstrong World Industries
  - b. Roppe Corporation
  - c. Nora Systems, Inc.

## **2.2 INSTALLATION MATERIALS**

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
  1. Adhesives shall have a VOC content of 50 g/L or less except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  1. Installation of resilient products indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
  1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### **3.3 RESILIENT BASE INSTALLATION**

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
  - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Form without producing discoloration (whitening) at bends.
  - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Miter or cope corners to minimize open joints.

### **3.4 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.
  - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513

## **SECTION 096516 - RESILIENT SHEET FLOORING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes vinyl sheet flooring.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples for Verification: For each exposed product and for each color and texture specified in manufacturer's standard size, but not less than 6-by-9-inch sections.
  - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

#### **1.3 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Resilient Sheet Flooring: Furnish not less than 20 linear feet, in roll form and in full roll width for each type, color, and pattern of flooring installed.

#### **1.4 FIELD CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient sheet flooring during the following time periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. FloorScore Compliance: Resilient sheet flooring shall comply with requirements of FloorScore certification.



## 2.2 RESILIENT SHEET FLOORING

- A. Sheet Flooring -1 (**S-1**)
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid: Product Standard: ASTM F1913 Manufacturer: Mohawk Group, Thickness: 0080 inch, Wearing Surface: Smooth, Sheer Width: As standard with manufacturer 6 feet 7 inches, Seamless-Installation Method: Heat welded with color matching welding rod, Style: Medella Hues – C2062, Color: H5311 Natural White
  - 2. Acceptable Manufacturers:
    - a. Forbo Smaragd Eternal Original
    - b. Mannington Commercial

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.
- C. Seamless-Installation Accessories:
  - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
    - a. Color: Match flooring.
- D. Integral-Flash-Cove-Base Accessories:
  - 1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
  - 2. Cap Strip: Square metal, provided or approved by resilient sheet flooring manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

### 3.2 PREPARATION

- A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient sheet flooring manufacturer's written recommendations, but not less stringent than the following:
  - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
  - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

### **3.3 RESILIENT SHEET FLOORING INSTALLATION**

- A. Comply with manufacturer's written instructions for installing resilient sheet flooring.
- B. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
- C. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.
- D. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- E. Seamless Installation:
  1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
- F. Integral-Flash-Cove Base: Cove resilient sheet flooring 6 inches up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

### **3.4 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.
- B. Perform the following operations immediately after completing resilient sheet flooring installation:
  1. Remove adhesive and other blemishes from surfaces.
  2. Sweep and vacuum surfaces thoroughly.
  3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096516

**SECTION 096519 - RESILIENT TILE FLOORING****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Vinyl Composite Floor Tile (VCT)
  - 2. Luxury Vinyl Floor Tile (LVT)

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
  - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  - 2. Show details of special patterns.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.

**1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

## 1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:
  1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation and for 48 hours after floor tile installation.
- D. Install floor tile after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
  1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
  2. Flame Spread: Not more than 75 as per ASTM E 84. Smoke Developed: Not more than 450 as per ASTM E 84. Smoke Density: Not more than 450 as per NFPA 258.

### 2.2 RESILIENT TILE FLOORING

- A. **Vinyl Composite Tile-1 (VCT-1)**
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Armstrong Flooring, Style: Imperial Texture, Color: Washed Linen 51810 Size: 12" X 12", Gauge: 1/8"
  2. Acceptable Comparable Products:
    - a. Manufacturer: Tarkett, Style: VCT II, Color: True Beige 533, Size: 12" X 12", Gauge: 1/8"
    - b. Or approved equal

**B. Vinyl Composite Tile-2 (VCT-2)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Manufacturer: Armstrong Flooring, Style: Imperial Texture, Color: Earthstone Greige 51804 Size: 12" X 12", Gauge: 1/8"
2. Acceptable Comparable Products:
  - a. Manufacturer: Tarkett, Style: VCT II, Color: Mushroom 593 Size: 12" X 12", Gauge: 1/8"
  - b. Or approved equal

**2.3 LUXURY VINYL FLOOR TILE****A. Luxury Vinyl Tile -1 (LVT-1)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:  
Tile Standard: ASTM F1700, Class III  
Manufacturer: Armstrong Flooring, Style: Natural Creations, Color: NA310 Parsa, Irish Cream, Size: 18" X 36", Gauge: 1/8", Type: B, Embossed Surface, Wear layer thickness: 0.020", Edge Treatment: Micro-bevel
2. Acceptable Comparable Products
  - a. Manufacturer: Shaw Contract, Collection: Vertical Layers, Style: Unveil 0601V, Color: Bleached 01111, Size: 9" X 36", Gauge: 1/8", Embossed Surface, Wear layer thickness: 30 mil, Edge Treatment: Squared edge
  - b. Manufacturer: Patcraft, Collection: Anew, Color: Ivory 00110-V2, Size: 7.75" X 48", Gauge: 2.5mm, Wear layer thickness: 30 mil

**B. Luxury Vinyl Tile -2 (LVT-2)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:  
Tile Standard: ASTM F1700, Class III  
Manufacturer: Armstrong Flooring, Style: Natural Creations, Color: NA311 Parsa, Café au Lait, Size: 18" X 36", Gauge: 1/8", Wear layer thickness: 0.020", Edge Treatment: Micro-bevel
2. Acceptable Comparable Products
  - a. Manufacturer: Shaw Contract, Collection: Vertical Layers, Style: Unveil 0601V, Color: Faded 01103, Size: 9" X 36", Gauge: 1/8", Type: B, Embossed Surface, Wear layer thickness: 30 mil, Edge Treatment: Squared edge
  - b. Manufacturer: Patcraft, Collection: Anew, Color: Talc 00505-V2, Size: 7.75" X 48", Gauge: 2.5mm, Wear layer thickness: 30 mil

**2.4 INSTALLATION MATERIALS**

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
  - 4. Moisture Testing: Perform tests so that each test area does not exceed 1,000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity: General recommended humidity control level is between 35–55%.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

### **3.3 FLOOR TILE INSTALLATION**

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
  - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
  - 1. Lay tiles in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

### **3.4 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION 096519

## **SECTION 096813 - TILE CARPETING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes modular carpet tile.
- B. Related Requirements:
  1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
    - a. Review delivery, storage, and handling procedures.
    - b. Review ambient conditions and ventilation procedures.
    - c. Review subfloor preparation procedures.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
  1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
  2. Carpet tile type, color, and dye lot.
  3. Type of subfloor.
  4. Type of installation.
  5. Pattern of installation.
  6. Pattern type, location, and direction.
  7. Pile direction.
  8. Type, color, and location of insets and borders.
  9. Type, color, and location of edge, transition, and other accessory strips.
  10. Transition details to other flooring materials.
- C. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
  1. Carpet Tile: Full-size Sample.
  2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.



**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

**1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

**1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with CRI's "CRI Carpet Installation Standard."

**1.9 FIELD CONDITIONS**

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

**1.10 WARRANTY**

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  2. Failures include, but are not limited to, the following:
    - a. More than 10 percent edge raveling, snags, and runs.
    - b. Dimensional instability.
    - c. Excess static discharge.
    - d. Loss of tuft-bind strength.
    - e. Loss of face fiber.
    - f. Delamination.

3. Warranty Period: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCTS, GENERAL**

- A. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- B. Performance Characteristics: As follows:
  1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D 7330.
  2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
  3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D 2646.
  4. Delamination: Not less than 3.5 lbf/in. according to ASTM D 3936.
  5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
  6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
  7. Resistance to Insects: Comply with AATCC 24.
  8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
  9. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) according to AATCC 16, Option E.
  10. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- C. Applied Treatments:
  1. Soil-Resistance Treatment: Manufacturer's standard treatment.
  2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
    - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

### **2.2 CARPET TILE**

- A. Carpet Tile -1 (**CPT-1**)
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Interface Carpet Tiles, Collection: Net Effect, Style: B701, Color: 102888 Black Sea, Size: 25cm X 1m
  2. Acceptable Comparable Products:
    - a. Manufacturer: Shaw Contract, Collection: Hand Drawn, Style: Stipple Tile 5T116, Color: 13496 Ink, Size: 18" X 36"
    - b. Manufacturer: Patcraft, Collection: Material Paradox, Style: Backlit, Color: 00490 Spectrum, Size: 9" X 36"
- B. Carpet Tile-2 (**CPT-2**)
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Manufacturer: Interface Carpet Tiles, Collection: Whole Earth, Style: WE151, Color: 104480 Midnight, Size: 25cm X 1m
  2. Acceptable Comparable Products:

- a. Manufacturer: Shaw Contract, Collection: Creating Space, Style: Aware Tile 5T358, Color: 58496 Lacquer, Size: 18" X 36"
- b. Manufacturer: Patcraft, Collection: Material Paradox, Style: Nocturne, Color: 00490 Spectrum, Size: 9" X 36"

C. Carpet Tile -3 (**CPT-3**)

- 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Manufacturer: Interface Carpet Tiles, Collection: Simple Abstraction, Style: Veiled Brushwork, Color: 106007 Ink, Size: 25cm X 1m
- 2. Acceptable Comparable Products:
  - a. Manufacturer: Shaw Contract, Collection: Creating Space, Style: Conscious Tile 5T359, Color: 58496 Lacquer, Size: 18" X 36"
  - b. Manufacturer: Patcraft, Collection: Artefact, Style: Etched, Color: 00480 Underlying Layer, Size: 12" X 48"

## 2.3 WALK-OFF MAT

A. Walk Off Mat (**WALK**)

- 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Manufacturer: J+J Flooring, Collection: Catwalk Modular, Style: 7268, Color: 1429 Color OP, Size: 24" X 24"
- 2. Acceptable Comparable Products:
  - a. Manufacturer: Shaw Contract, Collection: Steppin Out, Style: Bon Jour II 60476, Color: 31485 Navy, Size: 12' Roll
  - b. Manufacturer: Patcraft, Collection: Foot in the Door II, Style: Walk Right in II 1304, Color: 00450 Navy, Size: 24" X 24"

## 2.4 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
  - 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Metal Edge/Transition Strips: Extruded aluminum with **mill** finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.

- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
  - 1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement unless otherwise specified by carpet manufacturer.
    - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. For raised access flooring systems, verify the following:
  - 1. Access floor substrate is compatible with carpet tile and adhesive if any.
  - 2. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than 1/8 inch, protrusions more than 1/32 inch, and substances that may interfere with adhesive bond or show through surface.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### 3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

### **3.4 CLEANING AND PROTECTION**

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
  - 2. Remove yarns that protrude from carpet tile surface.
  - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

## **SECTION 099123 - PAINTING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes surface preparation and the application of paint systems on the following exterior and interior substrates:
  - 1. Concrete.
  - 2. Concrete masonry units (CMU).
  - 3. Steel and iron.
  - 4. Galvanized metal.
  - 5. Aluminum (not anodized or otherwise coated).
  - 6. Gypsum board.
  - 7. Wood.
- B. Related Requirements:
  - 1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
  - 2. Division 32 "Exterior Improvements" for pavement markings paint.

#### **1.3 DEFINITIONS**

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. Indicate VOC content.

### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F
  1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

### **1.7 FIELD CONDITIONS**

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturer **(PT-1)**
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Sherwin-Williams Company (The).
  2. Acceptable Manufacturers:
    - a. Benjamin Moore & Co.
    - b. ICI Paints.
    - c. PPG Architectural Finishes, Inc.
    - d. Pratt & Lambert
  3. Color: Heron Plume SW6070
- B. Manufacturer **(PT-2)**
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Sherwin-Williams Company (The).
  2. Acceptable Manufacturers:
    - a. Benjamin Moore & Co.
    - b. ICI Paints.
    - c. PPG Architectural Finishes, Inc.
    - d. Pratt & Lambert
  3. Color: Santorini Blue SW7607
- C. Manufacturer **(PT-3)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Sherwin-Williams Company (The).
2. Acceptable Manufacturers:
  - a. Benjamin Moore & Co.
  - b. ICI Paints.
  - c. PPG Architectural Finishes, Inc.
  - d. Pratt & Lambert
3. Color: Indigo Batik SW7602

D. **Manufacturer (PT-4)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Sherwin-Williams Company (The).
2. Acceptable Manufacturers:
  - a. Benjamin Moore & Co.
  - b. ICI Paints.
  - c. PPG Architectural Finishes, Inc.
  - d. Pratt & Lambert
3. Color: Tricorn Black SW6258

E. **Manufacturer (PT-5)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Sherwin-Williams Company (The).
2. Acceptable Manufacturers:
  - a. Benjamin Moore & Co.
  - b. ICI Paints.
  - c. PPG Architectural Finishes, Inc.
  - d. Pratt & Lambert
3. Color: Mega Greige SW7031

F. **Manufacturer (PT-6)**

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  - a. Sherwin-Williams Company (The).
2. Acceptable Manufacturers:
  - a. Benjamin Moore & Co.
  - b. ICI Paints.
  - c. PPG Architectural Finishes, Inc.
  - d. Pratt & Lambert
3. Color: Warm Stone SW 7032

## 2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:



1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for exterior and interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24)].
1. Flat Paints and Coatings: 50 g/L.
  2. Nonflat Paints and Coatings: 150 g/L.
  3. Dry-Fog Coatings: 400 g/L.
  4. Primers, Sealers, and Undercoaters: 200 g/L.
  5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  7. Pretreatment Wash Primers: 420 g/L.
  8. Floor Coatings: 100 g/L.

### **2.3 BLOCK FILLERS**

- A. Block Filler, Latex, Interior/Exterior

### **2.4 PRIMERS/SEALERS**

- A. Primer Sealer, Latex, Interior
- B. Primer, Alkali Resistant, Water Based
- C. Primer Sealer, Interior, Institutional Low Odor/VOC
- D. Primer Sealer, Alkyd, Interior
- E. Primer, Bonding, Solvent Based

### **2.5 METAL PRIMERS**

- A. Primer, Alkyd, Anti-Corrosive, for Metal
- B. Primer, Galvanized, Water Based

### **2.6 DRYFALL COATINGS**

- A. Dry Fall, Latex, Eggshell: Pigmented, water-based, emulsion-type, fast-drying coating for use on interior plaster, concrete, gypsum board, primed wood, and metal ceilings.
  1. Gloss and Sheen Level: Manufacturer's standard eggshell finish.
- B. Water Based, Dry Fall for Galvanized Steel, Eggshell: Pigmented, water-based coating for direct application to cleaned, interior galvanized-metal ceiling surfaces and adjacent primed metals.
  1. Gloss and Sheen Level: Manufacturer's standard eggshell finish.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter:
  1. Concrete: 12 percent.
  2. Fiber-Cement Board: 12 percent.

3. Masonry (Clay and CMUs): 12 percent.
  4. Wood: 15 percent.
  5. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

### **3.3 APPLICATION**

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
  - 1. Paint the following work where exposed in mechanical or electric equipment rooms:
    - a. None (equipment, conduit, ducts, hangers, panels, etc.)
  - 2. Paint the following work where exposed in occupied spaces:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    - h. Other items as directed by Architect.
  - 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

### **3.4 CLEANING AND PROTECTION**

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### **3.5 INTERIOR and EXTERIOR PAINTING SCHEDULE**

- A. Water-Based Dry-Fall System:
  - 1. Prime Coat: Alkyd quick-dry primer for metal unless otherwise specified where substrate is specified:
  - 2. Intermediate and Topcoats: Water-based dry fall, eggshell:
- B. Concrete Substrates, Nontraffic Surfaces:
  - 1. Latex System:
    - a. Prime Coat: Primer sealer, latex, interior/exterior
    - b. Intermediate and Topcoat: Latex, interior/exterior, (Gloss Level 2), unless otherwise noted.
  - 2. Institutional Low-Odor/VOC Latex System:

- a. Prime Coat: Primer sealer, interior, institutional low odor/VOC.
  - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
  - c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2)
- A. Concrete Substrates, Traffic Surfaces:
- 1. Epoxy Concrete Floor Coating:
    - a. Prime Coat: Floor epoxy resin, gloss (Gloss Level 6).
    - b. Intermediate Coat: Floor epoxy resin, gloss (Gloss Level 6).
    - c. Topcoat: Floor epoxy resin, gloss (Gloss Level 6).
  - 2. Water-Based Clear Sealer System:
    - a. First Coat: Sealer, water based, for concrete floors.
    - b. Topcoat: Sealer, water based, for concrete floors.
- B. CMU Substrates:
- 1. Latex System:
    - a. Block Filler: Block filler, latex, interior/exterior.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, (Gloss Level 2 or Level 3 unless otherwise noted)
- C. Steel Substrates:
- 1. Latex over Alkyd Primer System:
    - a. Prime Coat: Primer, alkyd, anti-corrosive, for metal or primer, alkyd, quick dry, for metal.
    - b. Prime Coat: Shop primer specified in Section where substrate is specified.
    - c. Intermediate Coat: Latex, interior, matching topcoat.
    - d. Topcoat: Latex, interior, (Gloss Level 3), unless otherwise noted.
  - 2. Aluminum Paint System:
    - a. Prime Coat: Primer, alkyd, anti-corrosive, for metal.
    - b. Prime Coat: Shop primer specified in Section where substrate is specified.
    - c. Intermediate Coat: Aluminum paint.
    - d. Topcoat: Aluminum paint.
- D. Galvanized-Metal Substrates:
- 1. Latex over Waterborne Primer System:
    - a. Prime Coat: Primer, galvanized, water based.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, (Gloss Level 3), unless otherwise noted.
  - 2. Institutional Low-Odor/VOC Latex System:
    - a. Prime Coat: Primer, galvanized, water based.
    - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
- E. Aluminum (Not Anodized or Otherwise Coated) Substrates:
- 1. Alkyd System:
    - a. Prime Coat: Primer, vinyl wash.
    - b. Intermediate Coat: Alkyd, interior, matching topcoat.
    - c. Topcoat: Alkyd, interior, (Gloss Level 3).
  - 2. Aluminum Paint System:
    - a. Prime Coat: Primer, vinyl wash.
    - b. Intermediate Coat: Aluminum paint.
- F. Wood Substrates:
- 1. Latex over Alkyd Primer System:
    - a. Prime Coat: Primer sealer, alkyd, interior.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, (Gloss Level 3), unless otherwise noted.
- G. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System:
  - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC.
  - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
  - c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), unless otherwise noted.

END OF SECTION 099123

**SECTION 101419 - DIMENSIONAL LETTER SIGNAGE****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Dimensional characters.
    - a. Exterior fabricated channel dimensional characters.
    - b. Interior cut metal dimensional characters.

**1.2 COORDINATION**

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 3. Show message list, typestyles, graphic elements, and layout for each sign.
  - 4. Show locations of electrical service connections.
  - 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Dimensional Characters: Full-size Sample of dimensional character.
  - 2. Exposed Accessories: Full-size Sample of each accessory type.
- E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For signs to include in maintenance manuals.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer of products.

**1.7 FIELD CONDITIONS**

- A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
  - 1. Uniform Wind Load: As indicated on Drawings.
  - 2. Concentrated Horizontal Load: As indicated on Drawings.
  - 3. Other Design Load: As indicated on Drawings.
  - 4. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.2 DIMENSIONAL CHARACTERS

- A. Exterior Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.
1. Basis of Design: Product selections are based upon the primary manufacturer below., Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. ASI Sign Systems, Inc.
  2. Acceptable Manufacturers:
    - a. ACE Sign Systems, Inc.
    - b. Best Signs Systems
  3. Character Material: Sheet or plate aluminum.
  4. Material Thickness: Manufacturer's standard for size and design of character.
  5. Character Height: 10 inches.
  6. Character Depth: 1 inch.
  7. Finishes:
    - a. Integral Aluminum Finish: Anodized color as selected by Architect from full range of industry colors and color densities.
  8. Mounting: Concealed, painted aluminum back bar or bracket assembly.
  9. Typeface: Arial Narrow
- B. Interior Cut Metal Characters: Characters with uniform faces, square-cut, smooth, eased edges; precisely formed lines and profiles; and as follows:
1. Basis of Design: Product selections are based upon the primary manufacturer below., Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. ASI Sign Systems, Inc.
  2. Acceptable Manufacturers:
    - a. ACE Sign Systems, Inc.
    - b. Best Signs Systems
  3. Character Material: Sheet or plate aluminum.
  4. Material Thickness: Manufacturer's standard for size and design of character.
  5. Character Height: 6 inches.
  6. Character Depth: 1/2 inch.
  7. Finishes:
    - a. Integral Aluminum Finish: Anodized color as selected by Architect from full range of industry colors and color densities.
  8. Mounting: Concealed, painted aluminum back bar or bracket assembly.
  9. Typeface: Arial Narrow



### 2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

### 2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. For exterior exposure, furnish hot-dip galvanized devices unless otherwise indicated.
  - 3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    - b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant Allen-head slots unless otherwise indicated.
  - 4. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

### 2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling

limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

## **2.6 GENERAL FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
  3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
  2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
  3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
  4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
  5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

**3.3 ADJUSTING AND CLEANING**

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

**SECTION 101423 - PANEL SIGNAGE****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  1. Panel signs.
  2. Room-identification signs.
  3. Field-applied, vinyl-character signs.

**1.3 DEFINITIONS**

- A. Accessible: In accordance with the accessibility standard.

**1.4 COORDINATION**

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
  1. Include fabrication and installation details and attachments to other work.
  2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
  3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
  4. Schedule for text content including space for providing modifications.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in size shown within documents unless otherwise indicated and as follows:
  1. Panel Signs: Full-size Sample.
  2. Room-Identification Signs: Full-size Sample.
  3. Field-Applied, Vinyl-Character Signs: Full-size Sample of characters on glass.
  4. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
  5. Exposed Accessories: Full-size Sample of each accessory type.
- D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

**1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For signs to include in maintenance manuals.

**1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

**1.9 FIELD CONDITIONS**

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

**1.10 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of embedded graphic image.
    - c. Separation or delamination of sheet materials and components.
  2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
  1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Accessibility Standard: Comply with applicable provisions in [the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

**2.2 SIGNS**

- A. Manufacturer:
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. ASI Sign Systems
      - 1) Reflection Wall Mounted Sign with raised letter and Braille
  2. Acceptable Manufacturers:
    - a. Best Sign Systems
    - b. InPro Corporation (IPC)
    - c. Mohawk Sign Systems
  3. Collection, finish, font and final arrangement to be selected and determined by Architect.
- B. Panel and Room Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles.
  1. Solid-Sheet Sign solid phenolic material sheet; engraved, etched, or blasted to create both raised relief, letters and Braille:
    - a. Thickness: As indicated and Manufacturer's standard for size of sign.
    - b. Engraved, Etched or Blasted Graphics: Sign face etched or routed to create both raised relief letters and Braille.
    - c. Profile: Square.
    - d. Corners: square
    - e. Fonts: Size shall be as indicated on drawings.
    - f. Finish and Color: as indicated on drawings.

2. Mounting: Manufacturer's standard method for substrates indicated and Surface mounted to wall with not less than 80% coverage double-sided tape over entire back of sign. If mounted on glass, provide back plate to hide mounting tape.
  3. Text and Typeface: Accessible raised characters and Braille, Arial font, upper-case, unless indicated on the drawings, center-justified as indicated.
  4. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner.
- C. Panel Exterior Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles.
1. Solid-Sheet Sign: Aluminum sheet with finish specified in "Surface Finish" Subparagraph as follows:
    - a. Thickness: Manufacturer's standard for size of sign.
    - b. Surface-Applied, Flat Graphics: Applied baked enamel or powder coat.
    - c. Profile: Square.
    - d. Perimeter: Finish edges smooth.
    - e. Fonts: Size shall be as indicated on drawings.
    - f. Finish and Color: as indicated on drawings.
  2. Mounting: Manufacturer's standard method for substrates indicated.

### **2.3 FIELD-APPLIED, VINYL-CHARACTER SIGNS**

- A. Field-Applied, Vinyl-Character Sign: Prespaced characters die cut from 3- to 3.5-mil thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.
1. Size: As indicated on Drawings
  2. Substrate: As scheduled on Drawings
  3. Text and Font: As indicated on Drawings

### **2.4 ACCESSORIES**

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.
  2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
  3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

### **2.5 FABRICATION**

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side.

Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
  2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
- C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

## **2.6 GENERAL FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard.
- C. Mounting Methods:
  1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.



- a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
  - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
- D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.
- E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

### **3.3 ADJUSTING AND CLEANING**

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423

**SECTION 102113 - TOILET COMPARTMENTS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Phenolic Color thru toilet compartments configured as toilet enclosures.
- B. Related Requirements:
  - 1. Section 061053 "Miscellaneous Rough Carpentry" for blocking.
  - 2. Section 102800 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
- B. Shop Drawings: For toilet compartments.
  - 1. Include plans, elevations, sections, details, and attachment details.
  - 2. Show locations of cutouts for compartment-mounted toilet accessories.
  - 3. Show locations of centerlines of toilet fixtures.
  - 4. Show locations of floor drains.
  - 5. Show overhead support or bracing locations.
- C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
  - 1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch- square Samples of same thickness and material indicated for Work.
  - 2. Each type of hardware and accessory.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of toilet compartment, from manufacturer.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents and source.
  - 1. Door Hinges: One hinge(s) with associated fasteners.
  - 2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
  - 3. Door Bumper: One bumper(s) with associated fasteners.
  - 4. Door Pull: One door pull(s) with associated fasteners.
  - 5. Fasteners: Ten fasteners of each size and type.

**1.7 PROJECT CONDITIONS**

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.
- B. Do not deliver materials or begin installation until building is enclosed, with complete protection from outside weather, and building temperature maintained at a minimum of 60 degrees F (15.6 degrees C).

**PART 2 - PRODUCTS****2.1 PERFORMANCE REQUIREMENTS**

- A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 450 or less.
- C. Regulatory Requirements: Comply with applicable provisions in [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

**2.2 MATERIALS**

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: ASTM B 221.
- C. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
  - 1. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z.
  - 2. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvanized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- E. Stainless-Steel Castings: ASTM A 743/A 743M.
- F. Zamac: ASTM B 86, commercial zinc-alloy die castings.

**2.3 SOLID-PLASTIC TOILET COMPARTMENTS**

- A. Manufacturers:
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. ASI Global Partitions
  - 2. Acceptable Manufacturers:
    - a. Bobrick
    - b. Metpar Corp.
- B. Toilet-Enclosure Style: Phenolic Ultimate Privacy 72 - Floor Anchored, Overhead Braced.
- C. Door, Panel, and Pilaster Construction: ¾" solid phenolic with multiple resin-impregnated kraft sheets at high temperature and pressure. Phenolic core color shall be the same as the surface sheets.
  - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.

2. Heat-Sink Strip: Manufacturer's standard continuous, stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
  3. Color and Pattern: Refer to drawings.
  4. Door and Panel Height: 72 inches. Install 6" above finish floor.
- D. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- E. Brackets (Fittings):
1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

## 2.4 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
1. Material: Stainless steel.
  2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position or continuous, spring-loaded type.
  3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit with occupancy indicator designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Height of hook above floor to be within accessibility reach range.
  5. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

## 2.5 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- C. Door Size and Swings: Unless otherwise indicated, provide 26-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 33-inch- wide (32" clear opening) for compartments designated as accessible.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
1. Confirm location and adequacy of blocking and supports required for installation.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
  - 1. Maximum Clearances:
    - a. Pilasters and Panels: 3/8 inch.
    - b. Panels and Walls: 1 inch.
  - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
    - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
    - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

### **3.3 ADJUSTING AND CLEANING**

- A. Carefully remove and dispose all protective vinyl from partitions
- B. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.
- C. Clean surfaces and wash with mild soap. Do not use abrasives.

END OF SECTION 102113

## **SECTION 102213 - WIRE MESH PARTITIONS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Wire mesh equipment barriers.

#### **1.2 REFERENCES**

- A. Reference Standards: The following reference standards are provided to establish a level of quality for chain link fences and all necessary components thereof.
- B. ASTM A53/A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; latest edition.
- C. ASTM A121 – Standard Specification for Metallic-Coated Carbon Steel Barbed Wire; 2007: Class 2.
- D. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; latest edition.
- E. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; latest edition.
- F. ASTM A392 Zinc Coated Steel Chain Link Fence fabric.
- G. ASTM A428/A428M – Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles; latest edition.
- H. ASTM F567 – Standard Practice for Installation of Chain-Link Fence; latest edition.
- I. ASTM A780 Repair of Damage and Uncoated Areas of Hot Dip Galvanized Coatings.
- J. ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2008: Schedule 40.
- K. CLFMI CLF 2445 – Product Manual; Chain Link Fence Manufacturers Institute; latest edition.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Wire mesh equipment barriers.
- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver wire mesh items with cardboard protectors on perimeters of panels and doors and with posts wrapped and palleted to provide protection during transit and Project-site storage. Use vented plastic.
- B. Inventory wire mesh partition door hardware on receipt, and provide secure lockup for wire mesh partition door hardware delivered to Project site.
  1. Tag each item or package separately with identification, and include basic installation instructions with each item or package.

**1.5 FIELD CONDITIONS**

- A. Field Measurements: Verify actual dimensions of construction contiguous with wire mesh units by field measurements before fabrication.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. All materials, fittings, components hardware and accessories shall be hot dip galvanized in accordance with the related reference standards described above.
- B. Materials shall be new and products of recognized, reputable manufacturers having a minimum of 5 years' experience. The use of used, salvaged, re-rolled or refinished materials is not permitted.

**2.2 WIRE MESH EQUIPMENT BARRIERS**

- A. Steel Chain Link Fabric:
  1. Height, 10'-0" unless otherwise noted. Refer to Drawings.
  2. Mesh shall be 10 gauge (0.135 inch) crimped steel wire woven into 1-1/2 inch mesh, securely clinched to frame members.
  3. The fabric may be fabricated into a single piece to the height specified herein.
- B. Posts, Rails and Frames:
  1. Schedule 40 pipe, welded construction, minimum yield strength 30 KSI.

Line Post	2.375" OD
Corner Post	2.875" OD
Terminal Post	4.00" OD
Top Rail	1.66" OD
Brace Rail	1.66" OD

## 2. Wires:

Bottom Tension Wire	07 Gauge
Tie Wire	09 Gauge
Hog Rings	12 Gauge

3. Accessories: Provide all required accessories necessary for a complete installation.  
 4. Finishes: Hot Dip Galvanized.

**2.3 STEEL AND IRON FINISHES**

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.  
 B. Examine floors for suitable conditions where wire mesh items will be installed.  
 C. Examine walls to which wire mesh items will be attached for properly located blocking, grounds, and other solid backing for attachment of support fasteners.  
 D. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION OF WIRE MESH EQUIPMENT BARRIERS**

- A. Tolerances: Maximum variation from plumb: 1/4 inch.  
 B. Anchor wire mesh equipment barriers to floor with 3/8-inch-diameter, expansion anchors through post bases. Shim post bases as required to achieve level and plumb installation.  
 C. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if indicated on Shop Drawings.  
 D. Install gates complete with gate hardware.

**3.3 REPAIR**

- A. Repair of Galvanized Surfaces: Zinc-rich paint shall be used for repairing surface damages caused by shipping, handling or field installation. Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.



**3.4 ADJUSTING**

- A. Adjust gates to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Verify that latches and locks engage accurately and securely without forcing or binding.

**3.5 PROTECTION**

- A. Remove and replace defective work, including doors and framing that are warped, bowed, or otherwise unacceptable.

END OF SECTION 102213

**SECTION 102600 - WALL AND DOOR PROTECTION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to the Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Sheet wall protection
  - 2. Corner guards

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For each type of wall protection showing locations and extent.
  - 1. Include plans, elevations, sections, and attachment details.
- A. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  - 1. Corner Guards: 6 inches long. Include examples of joinery, corners, and field splices.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Material Certificates: For each type of exposed plastic material.
- B. Sample Warranty: For special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Corner Guards: Provide sixteen (16) full size extra quantity of corner guards.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Store wall protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
  - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
2. Warranty Period: Five years from date of Substantial Completion

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1

### **2.3 PLASTIC SHEET PANELING (FRP-1)**

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product of comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Marlite
  2. Acceptable Manufacturers:
    - a. Glasteel
    - b. Nudo
    - c. CS Acrovyn Wall Covering
  3. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  4. Nominal Thickness: Not less than 0.075 inch.
  5. Surface Finish: Pebbled.
  6. Color: White.

### **2.4 CORNER GUARDS (CG)**

- A. Surface-Mounted Corner Guards: Corner guard mounted over continuous retainer. Exposed surfaces shall be free of wrinkling, chipping, discoloration, or other imperfections.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product of comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Koroseal Korogard G100-Series Surface-Mounted corner guards
  2. Acceptable Manufacturers:
    - a. Babcock-Davis;
    - b. C-S Construction Specialties:

- c. InPro Corporation
  - d. JL Industries;
  - e. Nystrom, Inc.
3. Color: Refer to Drawings

## **2.5 FABRICATION**

- A. Fabricate wall protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## **2.6 FINISHES**

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
  - 1. For wall protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

### **3.3 INSTALLATION**

- A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall protection in locations and at mounting heights indicated on Drawings. If not indicated on Drawings, install at heights indicated below:
  - 1. Corner Guards: 4 inches above finished floor.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
  - 1. Provide anchoring devices and suitable locations to withstand imposed loads.

**3.4 CLEANING**

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

## SECTION 102800 – TOILET, BATH, AND LAUNDRY ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  1. Washroom accessories.
  2. Shower room accessories.
  3. Underlavatory guards.
  4. Custodial accessories.

#### 1.2 SECTION REQUIREMENTS

- A. Submittals: Product Data.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Sheet Steel: ASTM A 1008/A 1008M, 0.0359-inch minimum nominal thickness.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180).
- D. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- E. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- F. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

#### 2.2 TOILET AND BATH ACCESSORIES

- A. Grab Bar: 1 set of 18, 36, and 42 inch each for every accessible toilet location. Refer to plans and interior elevations for exact mounting heights and locations.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Material: Stainless steel, 0.05 inch thick.
  4. Mounting: Concealed.
  5. Gripping Surfaces: Slip-resistant texture.
  6. Outside Diameter: 1-1/4 inches for medium-duty applications.
- B. Grab Bar: 1 set of 18 and 48 inch each for every accessible shower location. Refer to plans and interior elevations for exact mounting heights and locations.

1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Material: Stainless steel, 0.05 inch thick.
  4. Mounting: Concealed.
  5. Gripping Surfaces: Slip-resistant texture.
  6. Outside Diameter: 1-1/4 inches for medium-duty applications.
- C. Soap Dispenser: 1 each for location where sinks(s) occur or unless noted otherwise.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Mounting: Surface-mounted
  4. Capacity: 40-fl oz.
  5. Finish: Satin-finish stainless steel
- D. Paper Towel Dispenser / Waste Receptacle: 1 each for location where sink(s) occur or unless noted otherwise.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Mounting: Semi-Recessed
  4. Capacity: 6.3 gal. waste container
  5. Finish: Satin-finish stainless steel
- E. Toilet Tissue Dispenser: 1 each for location where toilet(s) occur or unless noted otherwise.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Mounting: Surface-mounted
  4. Capacity: Two-rolls
  5. Finish: Satin-finish stainless steel
- F. Sanitary Napkin Disposal: 1 each for location where toilet(s) occur for women and individual toilet rooms or unless noted otherwise.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:

- a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Mounting: Surface-mounted
  4. Capacity: 1.0-gal.
  5. Finish: Satin-finish stainless steel
- G. Mirror Unit: 1 each Restroom Wall-hung Sink
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Frame: Stainless-steel channel.
  4. Size: 24" wide x 36" high.
  5. The bottom edge of the reflective surface to be installed at 40" (maximum) above finished floor.
- H. Shower Curtain Rod: 1 each for every Accessible Shower
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Frame: Stainless-steel.
  4. Size: 36" length
- I. Shower Curtain: 1 each for every Accessible Shower
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Material: Opaque, matte white vinyl, .008" thick, with antibacterial and flame-retardant agents.
  4. Hooks: Provide stainless steel in quantity required by curtain manufacturer.
  5. Size: 36" wide x 72" high.
- J. Folding Shower/Changing Seat: 1 each for every Accessible Shower
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)



3. Rectangular 22" wide seat, 5/16" thick solid phenolic. Frame and mounting bracket are type 304 stainless steel and self-locking mechanism. Supports up to 500 lbs. Projects 15-13/16" from wall.
- K. Robe Hook: 1 each for every Shower Room
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. Material: Satin finish stainless steel.
  4. Style: Double.
- L. Stainless Steel Utility Shelf: 1 each for Janitor Closet.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. Bobrick
  2. Acceptable Manufacturers:
    - a. Bradley
    - b. American Specialties, Inc. (ASI)
  3. 1248 Stainless Steel Wall Shelf with Mop/Broom Holders, 36" Length x 8" Width minimum (at Janitor/Housekeeping/Environmental Services Rooms).
- M. Undercounter lavatory pipe insulation wrap: 1 each for every toilet room lavatory and shower room lavatory.
1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted and approved by Architect prior to bid:
    - a. IPS Corporation
      - 1) LavGuard2
  2. Acceptable Manufacturers:
    - a. Plumberex
      - 1) Pro-Extreme
    - b. Grainger
      - 1) Truebro
  1. Material: Rigid high-impact, stain resistant antimicrobial PVC Nonabsorbent with self locking snap fasteners.
  2. Color: White.
  3. Locations: Insulate all exposed drainage piping and water supplies (cold and tempered) exposed under sinks and countertops.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
1. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

2. Install per ADA requirements and details on sheet A4.
- B. Install benches by fastening bench tops to pedestals and securely anchoring to the floor using appropriate anchors for the floor material.
  - C. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.

END OF SECTION 102800

## **SECTION 104416 - FIRE PROTECTION CABINETS and EXTINGUISHERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Fire-protection cabinets for the following:
    - a. Portable fire extinguishers.
  2. Portable, hand-carried fire extinguishers

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing semi-recessed-method and relationships of box and trim to surrounding construction.
- B. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- C. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- D. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semi-recessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Include wall thickness for locations and coordinate cabinet depth.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For fire-protection cabinets and extinguishers.

#### **1.5 COORDINATION**

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers and hose valves indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

#### **1.6 SEQUENCING**

- A. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

#### **1.7 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10.
    - b. Faulty operation of valves or release levers.
  2. Warranty Period: **Six** years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

## 2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Manufacturers:
  - 1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. JL Industries; Cosmopolitan Series
  - 2. Acceptable Manufacturers:
    - a. Larsen's; Architectural Series
    - b. Nystrom; Alpine Series
- C. Cabinet Construction: Nonrated.
- D. Cabinet and Door Material: Cold rolled steel sheet.
- E. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
  - 1. Square-Edge Trim: 1-1/2-inch backbend depth.
- F. Door Style: Vertical duo panel with frame.
- G. Door Glazing: Acrylic sheet.
  - 1. Acrylic Sheet Color: Clear transparent acrylic sheet.
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide manufacturer's standard.
  - 2. Provide manufacturer's standard hinge permitting door to open 180 degrees.
- I. Accessories:
  - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
  - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
    - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
      - 1) Location: Applied to cabinet door.
      - 2) Application Process: Pressure-sensitive vinyl letters.
      - 3) Lettering Color: Black.
      - 4) Orientation: Vertical.
- J. Materials:
  - 1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
    - a. Finish: Baked enamel or powder coat white

## 2.3 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
  - 1. Manufacturers:
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Amerex
    - b. Acceptable Manufacturers:
      - 1) Badger
      - 2) Sentry

2. Valves: Manufacturer's standard.
  3. Handles and Levers: Manufacturer's standard.
  4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
1. Manufacturers:
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Amerex
    - b. Acceptable Manufacturers:
      - 1) Badger
      - 2) Sentry
- C. Halotron I clean agent, UL-rated 2-B:C (Radio Equipment Room):
1. Manufacturers:
    - a. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
      - 1) Amerex
    - b. Acceptable Manufacturers:
      - 1) JL Industries Incorporated
      - 2) Larsen

## 2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
  2. Provide factory-drilled mounting holes.
  3. Prepare doors and frames to receive locks.
  4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
  2. Fabricate door frames of one-piece construction with edges flanged.
  3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.
- B. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets will be installed.
- C. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Prepare recesses for semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

**3.3 INSTALLATION**

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below
  - 1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semi-recessed fire-protection cabinets.
  - 2. Provide inside latch and lock for break-glass panels.
  - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification: Apply vinyl lettering at locations indicated.

**3.4 ADJUSTING AND CLEANING**

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104416

## **SECTION 105500 - PACKAGE RECEIVERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Package Receivers.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of postal specialty.
- B. Shop Drawings: For postal specialties.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include setting drawings, templates, and installation instructions for anchor bolts and other anchorages installed as part of the Work of other Sections.
- C. Samples for Verification: For each type of exposed finish, prepared on 6-by-6-inch-square Samples.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For special warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For postal specialties and finishes to include in maintenance manuals.

#### **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Key Blanks: 3 for every lock or fraction thereof, for each type of compartment-door lock installed.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Furnish lock keys with temporary identification for their respective locks, bagged, and securely taped inside the collection compartment for shipping.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of postal specialties that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation of hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

## PART 2 - PRODUCTS

### 2.1 PACKAGE RECEIVERS

- A. Bullet Resistant Package Receiver: Consisting of 12-gauge steel body, with interlocking device to allow for only one door at a time to be opened. Exterior door is stainless steel with outside door release from interior. Locking paddle latch on interior door and pull handle on exterior door with automatic exterior door closers. Prime painted mounting flange on exterior is welded with the interior flange adjustable to accommodate various wall thickness.
  1. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Armortex Package Receiver SSPR-1818
  2. Acceptable Manufacturers:
    - a. Covenant Security
    - b. NBP (National Bullet Proof, Inc.)
  3. Size: 18" x 18".
  4. Ballistic Level: Level 3, bullet resistant armor in doors.
  5. Body:
    - a. 12 gauge prime painted steel.
    - b. Door interlock mechanism.
    - c. Automatic door closer.
  6. Threat Side:
    - a. Pull Handle.
    - b. Stainless Steel Door.
  7. Safe Side:
    - a. Paddle Latch with Keylock.
    - b. 16 gauge prime painted door.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions for compliance with requirements for roughing-in openings, clearances, and other conditions affecting performance of the Work.
- B. Examine walls and other adjacent construction for suitable conditions where units will be installed.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install package receiver level and plumb, according to manufacturer's written instructions and roughing-in drawings.
  - 1. Where dissimilar metals are in permanent contact with each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturer for this purpose.
  - 2. Where aluminum contacts grout, concrete, masonry, or wood, protect against corrosion by painting contact surfaces with bituminous coating.
- B. Bullet-Resistant Package Receiver: Locate package receiver box at location indicated on Drawings or as directed by Architect.

### **3.3 ADJUSTING, CLEANING, AND PROTECTION**

- A. Remove temporary protective coverings and strippable films, if any, as package receivers are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust doors, hardware, and moving parts to function smoothly, and lubricate as recommended by manufacturer. Verify that integral locking devices operate properly.
- C. Touch up marred finishes or replace specialties that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by manufacturer.
- D. Replace specialties that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- E. On completion of installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION 105500

## **SECTION 105613 - METAL STORAGE SHELVING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Heavy-duty metal storage shelving.

#### **1.3 COORDINATION**

- A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.
- B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.
- B. Shop Drawings: For metal storage shelving.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include installation details of connectors, lateral bracing, and special bracing.
- C. Samples: For each type of metal storage shelving and for each color specified, in the following sizes:
  - 1. Vertical Supports: 12 inches tall.
  - 2. Shelves: Full size, but not more than 60 inches wide by 30 inches deep; 108 inches tall.
  - 3. Connectors: Full size.

- 4. Shelf-Label Holders: Full size.
- D. Product Schedule: For metal storage shelving. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For seismic restraint of metal storage shelving.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of metal storage shelving.

#### **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

#### **1.8 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Shelves: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 5 shelves.
  - 2. Shelf-to-Post Connectors: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 connectors.
  - 3. Shelf-Label Holders: Full-size units equal to 5 percent of amount installed for each type indicated, but no fewer than 10 holders.

#### **1.9 QUALITY ASSURANCE**

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

#### **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants during the remainder of the construction period.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain metal storage shelving from single source from single shelving manufacturer.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Seismic Component Importance Factor: 1.5.

### **2.3 HEAVY-DUTY METAL STORAGE SHELVING**

- A. Open Metal Storage Shelving: Complying with MH 28.1 and field assembled from factory-formed components. Shelves span between supporting corner posts that allow shelf-height adjustment over full height of shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.
  - 1. Load-Carrying Capacity per Shelf: Minimum 900 lb.
  - 2. Posts: Fabricated from cold-rolled steel; in manufacturer's standard shape; with perforations at 1-1/2 inches o.c. to receive shelf-to-post connectors.
    - a. Unit Configuration: Configure shelving units as individual assemblies.
      - 1) Add-On Shelf Posts: Fabricated from hot-rolled steel, manufacturer's standard shape; perforated to match main posts.
    - b. Post Base: Adjustable steel floor plate, drilled for floor anchors.
  - 3. Bracing: Manufacturer's standard, diagonal cross bracing.
    - a. Location: At unit back as required for stability, load-carrying capacity of shelves, and number of shelves indicated.
    - b. Steel Sheet Thickness, Nominal: As required for load-carrying capacity per shelf.
  - 4. Solid-Type Shelves:
    - a. Steel Sheet: Nominal thickness as required for load-carrying capacity per shelf.
  - 5. Shelf Quantity: Five shelves per shelving unit in addition to top and bottom shelf.
  - 6. Shelf-to-Post Connectors: Manufacturer's standard connectors.

7. Base: Closed, with base strips fabricated from same material and with same finish as shelving.
8. Overall Unit Width: 60 inches, inclusive of two end posts.
9. Overall Unit Depth: 30 inches.
10. Overall Unit Height: 108 inches.
11. Steel Finish: Baked enamel or powder coat.
  - a. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.4 ANCHORS

- A. Floor Anchors: Galvanized-steel. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.
- B. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide one per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

## 2.5 FABRICATION

- A. Fabricate metal storage shelving components to provide field-assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
  1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
  2. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
  3. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.
- B. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- C. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a hem on the concealed side; ease edges of metal plate to radius of approximately 1/32 inch. Shear and punch metals cleanly and accurately. Remove burrs.
- D. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so surface is smooth after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine floors for suitable conditions where metal storage shelving will be installed.
- C. Examine walls and ceilings to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Vacuum and clean finished floor over which metal storage shelving is to be installed.

### **3.3 INSTALLATION**

- A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
  - 1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
  - 2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
  - 3. Adjust post-base bolt leveler to achieve level and plumb installation.
  - 4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
  - 5. Install seismic restraints.
  - 6. Connect side-to-side and back-to-back shelving units together.
  - 7. Install shelves in each shelving unit at spacing indicated on Drawings.

### **3.4 ERECTION TOLERANCES**

- A. Erect metal storage shelving to a maximum tolerance from vertical of 1/2 inch in up to 10 feet of height, not exceeding 1 inch for heights taller than 10 feet.
- B. Erect post-and-beam metal storage shelving to a maximum tolerance from vertical of 1/4 inch in 84 inches of height.

### **3.5 ADJUSTING**

- A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.

- B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
- C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- D. Replace metal storage shelving components that have been damaged beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

## **SECTION 105626 – MOBILE STORAGE SHELVING UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Mechanically assisted, carriage mounted high-density mobile storage units, support rails, fabrication, and installation including leveling of support rails.
- B. Related Work, Not Furnished:
  - 1. Structural floor system capable of supporting live and dead loads required by prevailing building codes, including rolling loads of storage units to be installed.
  - 2. Finish floor covering materials and installation on raised floors and ramps or when on concrete with recessed rail installation.
- C. Related Sections:
  - 1. Section 033000 – Cast-in-Place Concrete
  - 2. Sections in Division 9 – Finishes, relating to finish floor and base materials.

#### **1.3 REFERENCES**

- A. American Library Association (when applicable)
  - 1. Cantilever Bracket Type Metal Library Bookstacks; Library Technology Reports.
- B. American National Standards Institute (ANSI) Standards:
  - 1. Applicable standards for fasteners used for assembly.
- C. American Society for Testing and Materials (ASTM) Standards:
  - 1. Applicable standards for steel materials used for fabrication.
- D. American Institute Of Steel Construction (AISC) Standards:
  - 1. Applicable standards for steel materials used for fabrication.

#### **1.4 SYSTEM DESCRIPTION**

- A. General: The system consists of manufactured storage units mounted on manufacturer's track-guided carriages to form a compact storage system. System design permits access to any single aisle by manually moving units until the desired



aisle is opened. The carriage/rail system provides uniform carriage movement along the total length of travel, even with unbalanced loads.

- B. Carriage System Design and Features: The carriage system consists of a formed structural steel frame with machined and balanced wheels riding on steel surface mounted to the floor. Rails shall be types selected by the manufacturer to ensure smooth operation and self-centering of mobile storage units during travel without end play or binding. Rail types, quantities and spacing shall be selected by the manufacturer to suit installation conditions and requirements. All bearings used in the drive mechanism shall be permanently shielded and lubricated.
- C. Movement Controls: Triple or single arm operating wheels with rotating hand knobs shall be provided on the accessible drive ends of shelf units, centered on the end panel, located 40 inches from the base of each unit to permit units to be moved to create a single aisle opening. Turning the handle transmits power through chain drive to drive wheels on each carriage.
- D. Drive System: The system shall be designed with a positive type mechanically-assisted drive which minimizes end play, ensures there is no play in the drive handle, and that carriages will stop without drifting.
  - 1. System shall include a chain sprocket drive system for each movable carriage to ensure that carriages move uniformly along the total length of travel, even with unbalanced loads. All system components shall be selected to ensure a smooth, even movement along the entire carriage length. Drive system gearing shall be designed to permit 1 lb. of force applied to the drive handle to move a minimum of 4,000 lbs. of load.
  - 2. A tensioning device shall be provided on each chain drive with provision for adjusting tension without removing end panels.
  - 3. All bearings used in the drive mechanism shall be permanently shielded and lubricated.
- E. Safety Features:
  - 1. Color-coded visual indicators shall provide verification that carriages are in a locked or unlocked mode.
  - 2. A single safety lock button, mounted on each operating wheel hub, will permit moving a carriage in either direction to create a new access aisle when pulled out unlocked, or locking the carriage when pushed in.
- F. Finishes:
  - 1. Fabricated Metal Components And Assemblies: Manufacturer's standard powder coat paint finish.
  - 2. End Panels, Accessible Ends: Manufacturer's standard powder coat paint finish.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Ease of Movement: Provide mechanically assisted units capable of being moved by exerting a maximum horizontal force of 5 pounds on the operating wheel.

- B. Seismic Performance: Provide mobile storage units capable of withstanding the effects of earthquake movement when required by applicable building codes.

## 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature and installation instructions for each type of shelving, track and installation accessory required. Include data substantiating that products to be furnished comply with requirements of the contract documents.
- B. Shop Drawings: Show fabrication, assembly, and installation details including descriptions of procedures and diagrams. Show complete extent of installation layout including clearances, spacings, and relation to adjacent construction in plan, elevation, and sections. Indicate clear exit and access aisle widths; access to concealed components; assemblies, connections, attachments, reinforcement, and anchorage; and deck details, edge conditions, and extent of finish flooring within area where units are to be installed.
  - 1. Show installation details at non-standard conditions. Furnish floor layouts, technical and installation manuals for every unit shipment with necessary dimensions for rail layout and system configuration at the project site. Include installed weight, load criteria, furnished specialties, and accessories.
  - 2. Provide layout, dimensions, and identification of each unit corresponding to sequence of installation and erection procedures. Specifically include the following:
    - a. Location, position and configuration of tracks on all floors.
    - b. Plan layouts of positions of carriages, including all required clearances.
    - c. Details of shelving, indicating method and configuration of installation in carriages.
  - 3. Provide location and details of anchorage devices to be embedded in or fastened to other construction.
  - 4. Provide installation schedule and complete erection procedures to ensure proper installation.
- C. Samples: Provide minimum 3 inch square example of each color and texture on actual substrate for each component to remain exposed after installation.
- D. Selection Samples: For initial selection of colors and textures, submit manufacturer's color charts consisting of actual product pieces, showing full range of colors and textures available.
- E. Warranty: Submit draft copy of proposed warranty for review by the Architect/Engineer.
- F. Maintenance Data: Provide in form suitable for inclusion in maintenance manuals for mobile storage units. Data shall include operating and maintenance instructions, parts inventory listing, purchase source listing, emergency instructions, and related information.
  - 1. Submit manufacturer's instructions for proper maintenance materials and procedures.

2. Submit manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions. Include precautions against using materials and methods which may be detrimental to finishes and performance.

### **1.7 QUALITY ASSURANCE**

- A. **Manufacturer Qualifications:** Engage an experienced manufacturer who is ISO 9001 certified for the design, production, installation and service of carriage mounted high-density mobile storage units and support rails. Furnish certificate attesting manufacturer's ISO 9001 quality system registration.
- B. **Installer Qualifications:** Engage an experienced installer who is a manufacturer's authorized representative for the specified products for installing carriages and anchoring shelving units to carriages.
  1. **Minimum Qualifications:** 1-year experience installing systems of comparable size and complexity to specified project requirements.
  2. **Guaranteed 24-hour service response time.**

### **1.8 DELIVERY, STORAGE AND HANDLING**

- A. Follow manufacturer's instructions and recommendations for delivery, storage and handling requirements.

### **1.9 PROJECT CONDITIONS**

- A. **Field Measurements:** Verify dimensions before fabrication. Indicate verified measurements on Shop Drawings. Coordinate fabrication and delivery to ensure no delay in progress of the Work.
- B. **Established Dimensions:** Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating mobile storage units. Coordinate construction to ensure actual dimensions correspond to established dimensions.

### **1.10 SEQUENCING AND SCHEDULING**

- A. **Sequencing:** Coordinate storage shelving system installation with other work to minimize possibility of damage and soiling during remainder of construction period.
- B. **Scheduling:** Plan installation to commence after finishing operations, including painting have been completed.
- C. **Built-In Items:** Provide components which must be built in at a time which causes no delays general progress of the Work.
- D. **Pre-installation Conference:** Schedule and conduct conference on project site to review methods and procedures for installing mobile storage units including, but not limited to, the following:

1. Review project conditions and levelness of flooring and other preparatory work performed under other contracts.
2. Review and verify structural loading limitations.
3. Recommended attendees include:
  - a. Owner's Representative.
  - b. Prime Contractor or representative.
  - c. The Architect.
  - d. Manufacturer's representative.
  - e. Subcontractors or installers whose work may affect, or be affected by, the work of this section.

### **1.11 WARRANTY**

- A. Provide a written warranty, executed by Contractor, Installer, and Manufacturer, agreeing to repair or replace units which fail in materials or workmanship within the established warranty period. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have under General Conditions provisions of the Contract Documents.
- B. Warrant the entire movable compact shelving installation against defects in materials and workmanship for a period of five years from date of acceptance by the Owner.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
  1. High-Density Mobile Shelving by Southwest Solutions Group (SSG)
- B. Acceptable Manufacturers:
  1. Space Saver High-Density Mobile Shelving
  2. Hi-Density Spacesaving Systems

### **2.2 BASIC MATERIALS**

- A. General: Provide materials and quality of workmanship which meet or exceed established industry standards for products specified. Material thicknesses/gauges are manufacturer's option unless indicated otherwise.
- B. Plastic Laminates: NEMA LD-3, GP-28, Vertical Grade.

## 2.3 GROUT

- A. General: Provide non-shrink, non-staining hydraulic cement compound conforming to the following requirements, based on the performance of the test specimens at room temperature and in laboratory air.
1. Linear Movement: No shrinkage while setting; maximum expansion limited to .002 inches per linear inch.
  2. Compressive Strength: Based on two inch cubes made following ASTM standards, tested on a Balding-Southward machine of 60,000 pounds capacity, meet or exceed the following:
    - a. Age:      1 hour ---- 4,500 psi  
              7 days ---- 8,000 psi

## 2.4 MANUFACTURED COMPONENTS

- A. Rails:
1. Material: ASTM/AISI Type 1035 or 1045 steel, manufacturer's selection.
  2. Capacity: 1,000 pounds per lineal foot of carriage.
  3. Minimum Contact Surface: 5/8 inch wide.
  4. Provide rail sections in minimum 6 foot lengths.
  5. Rail configuration shall permit attachment to top of structural floor system with provision for leveling rails to compensate for variations in floor surface level.
  6. Provide rail connections designed to provide horizontal and vertical continuity between rail sections, to gradually transfer the concentrated wheel point load to and from adjoining rail sections. Butt joints are not permitted.
  7. Anti-Tip Rail Form Covers: Manufacturer shall provide for protection if required to prevent damage to rails during concrete back pours and when anti-tip devices are installed.
- B. Floor / Ramp:
1. Floor/Ramp Sheathing: Minimum 3/4 inch, 5-ply underlayment grade plywood. Particle board sheathing materials are not permitted.
  2. Provide fire retardant treated floor/ramp materials when required by code.
  3. Finished flooring materials shall be provided by the Owner.
- C. Carriages:
1. Provide manufacturer's design movable carriages fabricated of welded or bolted steel construction. Galvanized structural components and/or riveted carriages are unacceptable.
  2. Provide fixed carriages of same construction and height as the movable carriages, anchored to rails. Setting fixed shelving directly on floors is not permitted.
  3. When required, provide bolted carriage splices designed to maintain proper unit alignment and weight load distribution.

4. Design carriages to allow the shelving uprights to recess and interlock into the carriages a minimum of 3/4 inch. Top mount carriages are unacceptable.
  5. Provide each carriage with two wheels per rail.
- D. Drive / Guide System:
1. Design: Provide drive system which prevents carriage whipping, binding and excessive wheel/rail wear under normal operation.
    - a. If line shafts are used, all wheels on one side of carriage shall drive.
    - b. If synchronized drives are used, a minimum of one wheel assembly driving both sides of carriage at center location required. Drive shaft shall exhibit no play or looseness over the entire length of that assembly.
  2. Shafts: Solid steel rod or tube.
  3. Shaft Connections: Secured couplings.
  4. Bearing Surfaces: Provide rotating load bearing members with ball or roller bearings. Provide shafts with pillow block or flanged self-aligning type bearings.
- E. Wheels:
1. Capacity: Minimum load capacity per wheel: 3200 lbs.
  2. Size: Minimum 5 inches, outside diameter drive wheels.
  3. Guides: Determined by manufacturer; minimum 2 locations.
- F. Face Panels:
1. Materials: Plastic laminate clad particle board with plastic edging on vertical edges.
  2. Finishes: Selected from manufacturer's standard available colors and patterns.
- G. Accessories:
1. Anti-Tip Devices: Provide manufacturer's standard fixtures.
  2. Mechanical Sweep and Safety Stop (Non-Powered).

Every potential aisle shall be protected with a 3" high extruded aluminum safety sweep, hinged from the carriage using spring steel leaf springs, with the base edge maximum 3/4" from the floor. The carriage(s) shall stop when depressed at any location along the leading edge of the sweep surface. Activated safety sweep shall engage an impact- absorbing friction disk brake to protect occupants, stored media and the carriage system itself via a sheathed cable system comprised of aircraft-grade 3/64" stainless steel core cables housed inside lined conduit. Safety sweep shall have bright, red and white safety identification tape applied full length marking its location. Safety sweep shall run the full length of both sides of each moveable carriage for full aisle coverage.

Mechanical safety sweep shall automatically reset to enable mobile system users to freely and safely back carriages away from aisle obstructions simply by reversing the direction of the rotating handle.

Safety sweep shall be operational when the carriages are not moving. Should a

sweep be activated in an open aisle, the carriage with the activated sweep will not close on that aisle. Safety sweep shall automatically reset if activated and then released when the carriages are not moving.

Safety sweep shall require no electrical power or batteries to operate.

## **2.5 FABRICATION**

- A. General: Coordinate fabrication and delivery to ensure no delay in progress of the Work.
- B. Wheels: Provide precision machined and balanced units with permanently shielded and lubricated bearings.
- C. Carriages: Fabricate to ensure no more than 1/4 inch (6MM) maximum deviation from a true straight line. Splice and weld to ensure no permanent set or slippage in any spliced or welded joint when exposed to forces encountered in normal operating circumstances.
- D. Shelving, Supports and Accessories: See individual descriptions in "Shelving" paragraphs.

## **2.6 FINISHES**

- A. Colors: Selected from manufacturer's standard available colors.
- B. Paint Finish: Provide factory applied electrostatic powder coat paint. Meet or exceed specifications of the American Library Association.
- C. Laminate Finish: Provide factory applied laminate panels at locations indicated on approved shop drawings.
- D. Edgings: Provide preformed edging, color-matched to unit colors selected.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine floor surfaces with Installer present for compliance with requirements for installation tolerances and other conditions affecting performance of mobile storage units.
- B. Verify that building structural system is adequate for installing mobile storage units at locations indicated on approved shop drawings.
  - 1. In new construction, ensure that recesses for rails in floors are at proper spacing and depths, with allowance for grouting.
  - 2. For installations on existing floors, ensure that rail spacings indicated on shop drawings are in proper locations so existing load-bearing structural members are not over stressed.

- C. Verify that intended installation locations of mobile storage units will not interfere with nor block established required exit paths or similar means of egress once units are installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to proper performance of mobile storage units, once installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Rails:
  1. Lay out rails using full length units to the maximum extent possible. Use cut lengths only at ends to attain total length required. Locate and position properly, following dimensions indicated on approved shop drawings. Verify thickness of finished floor materials to be installed (by others) and install level 1/16 inch above finished floor surfaces.
  2. Verify level, allowing for a minimum 1/4 inch of grout under high points. Position and support rails so that no movement occurs during grouting.
  3. Set rails in full grout bed, completely filling any voids entire length of all rails including rail connectors. Trim up sides flush with rails to ensure proper load transfer from rail to supporting floor. Using shims in lieu of full grouting is not permitted.
  4. Installation Tolerances: Do not exceed levelness of installed rails listed below:
    - a. Maximum Variation From True Level Within Any Module: 3/32 inch.
    - b. Maximum Variation Between Adjacent (Parallel) Rails: 1/16 inch, perpendicular to rail direction.
    - c. Maximum Variation In Height: 1/32 inch, measured along any 10 foot rail length.
  5. Verify rail position and level; anchor to structural floor system with anchor type and spacings indicated on approved shop drawings.
- B. Floors/Ramps:
  1. General: Finished elevation shall be 1/16 inch below top of rails.
  2. Place floors and ramps to the extent indicated on approved shop drawings. Extend ramps under all movable ranges. Provide ramp at both ends of mobile system. Do not extend ramps beyond the ends of carriages.
  3. Construct floors and ramps to prevent warping or deformation of floor panels in a normal operating environment. Support panels on levelers at maximum 16 inches on center.
  4. Ramp Slope: Do not exceed the following:
    - a. ADA Accessible Ramps: Maximum 1:12 slope (4.76 degrees).
    - b. Other Ramps: Maximum 9 degree slope (1.9:12).
    - c. Vertical Transition, Ramp edge to floor: Maximum 1/8 inch (3MM).



- C. Shelving Units Installation:
1. General: Follow layout and details shown on approved shop drawings and manufacturer's printed installation instructions. Position units level, plumb; at proper location relative to adjoining units and related work.
  2. Carriages:
    - a. Place movable carriages on rails. Ensure that all wheels track properly and centering wheels are properly seated on centering rails. Fasten multiple carriage units together to form single movable base where required.
    - b. Position fixed carriage units to align with movable units.
  3. Shelving Units:
    - a. Permanently fasten shelving units to fixed and movable carriages with vibration-proof fasteners.
    - b. Stabilize shelving units following manufacturer's written instructions. Reinforce shelving units to withstand the stress of movement where required and specified.

### **3.3 FIELD QUALITY CONTROL**

- A. Verify shelving unit alignment and plumb after installation. Correct if required following manufacturer's instructions.
- B. Remove components which are chipped, scratched, or otherwise damaged and which do not match adjoining work. Replace with new matching units, installed as specified and in manner to eliminate evidence of replacement.

### **3.4 ADJUSTING**

- A. Adjust components and accessories to provide smoothly operating, visually acceptable installation.

### **3.5 CLEANING**

- A. Immediately upon completion of installation, clear components and surfaces. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

### **3.6 DEMONSTRATION/TRAINING**

- A. Schedule and conduct demonstration of installed equipment and features with Owner's personnel.
- B. Schedule and conduct maintenance training with Owner's maintenance personnel. Training session should include lecture and demonstration of all maintenance and repair procedures that end user personnel would normally perform.

**3.7 PROTECTION**

- A. Protect system against damage during remainder of construction period. Advise Owner of additional protection needed to ensure that system will be without damage or deterioration at time of substantial completion.

END OF SECTION 105626

**SECTION 107516 - GROUND-SET FLAGPOLES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes ground-set flagpoles made from aluminum.
- B. Owner-Furnished Material: (3) Flags.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For flagpoles.
  - 1. Include plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
  - 2. Include section, and details of foundation system.
- C. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.
- D. Delegated-Design Submittal: For flagpoles.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.

### **2.3 ALUMINUM FLAGPOLES**

- A. Aluminum Flagpoles: Cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch.
  - 1. Basis-of-Design Product: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid:
    - a. Concord Industries, Inc.
  - 2. Acceptable Manufacturers:
    - a. Pole-Tech, Inc.
    - b. HD Flagpoles
- B. Exposed Heights:
  - 1. 40 feet
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
  - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
  - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- D. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
  - 1. Flashing Collar: Same material and finish as flagpole.

### **2.4 FITTINGS**

- A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.

1. 0.063-inch spun aluminum with gold anodic finish.
- B. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
1. Halyard Flag Snaps: Stainless-steel swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.

## **2.5 MISCELLANEOUS MATERIALS**

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.
- B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
- C. Sand: ASTM C 33/C 33M, fine aggregate.

## **2.6 ALUMINUM FINISHES**

- A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

# **PART 3 - EXECUTION**

## **3.1 PREPARATION**

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.
- F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to reinforcement.

- G. Place concrete, as specified in Section 033000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

### **3.2 FLAGPOLE INSTALLATION**

- A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION 107516

## **SECTION 116723 SHOOTING RANGE EQUIPMENT**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Shooting Range Equipment of the following types:
  - 1. Bullet Traps and Collection.
  - 2. Shooting Stalls.
  - 3. Baffles and Guards.
  - 4. Target Systems.
  - 5. Audio and Visual Communication Systems.
  - 6. Range Controls.

#### **1.2 REFERENCES**

- A. ASTM International (ASTM):
  - 1. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - 2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Materials.
- B. International Organization for Standardization (ISO):
  - 1. ISO 9001 - Quality Management.
  - 2. ISO 14001 - Environmental Management.
- C. Underwriters Laboratories (UL):
  - 1. UL 94 - Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances.
  - 2. UL 121.
  - 3. UL 752 - Standard for Bullet-Resisting Equipment.

#### **1.3 SUBMITTALS**

- A. Submit under provisions of Section 013300 - Submittals.
- B. Product Data:
  - 1. Manufacturer's data sheets on each product to be used.
  - 2. Preparation instructions and recommendations.
  - 3. Storage and handling requirements and recommendations.
  - 4. Typical installation methods.
- C. Shop Drawings: Include details of materials, construction, and finish. Include relationship with adjacent construction. Include all electrical data and connection details. Coordinate all details on drawings of the exact locations for mechanical work

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum 25 years documented experience.
- B. Supplier shall have a current and valid ISO 9001 Quality Management System and an ISO 14001 Environmental Management System.
- C. Installer Qualifications: Company specializing in performing Work of this section with Lead Supervisor / installer having a minimum two years documented experience with

projects of similar scope and complexity.

1. Installation shall be under the direct supervision of the Manufacturer.

- D. Source Limitations: Provide all products of this Section from a single manufacturing source to ensure compatibility and product performance capability.

## **1.5 PRE-INSTALLATION CONFERENCE**

- A. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Architect, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- B. Deliver all equipment boxed or crated to provide protection during transit and job storage.
- C. Inspect equipment upon delivery for damage. Minor damages may be repaired, provided the finish items are equal in all respects to new work and acceptable to the Owner and Architect; otherwise, remove and replace damaged items immediately.
- D. Store equipment at the site under cover in a secured place. Store equipment off the floor and in a manner to promote air circulation. Avoid the use of non-vented plastic or canvas shelters that could create a humidity chamber.

## **1.7 PROJECT CONDITIONS**

- A. Projects Prime Contractor to maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

## **1.8 WARRANTY**

- A. Manufacturer's Warranty: Provide manufacturer's standard limited warranty for defects in workmanship and materials for a period of one year from the date of substantial completion.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Acceptable Manufacturer: InVeris Training Solutions
- B. Substitutions: Not permitted.

### **2.2 BULLET TRAPS AND COLLECTION**

- A. Basis of Design: GranTrap, Model LE7500-OT; as manufactured and supplied by InVeris Training Solutions.
1. Performance and Design Requirements
- a. Maximum Bullet Velocity: 3600 ft per sec (1097 m per sec).
  - b. Maximum Bullet Energy: 3600 ft-lbs (4881 Nm).



2. Description: Designed for all small arms including handguns, shotguns, and rifles. Utilizes specialty treated rubber granulate made from recycled materials, that safely stops bullets and maintains their basic original shape, thus minimizing broken up lead particles released into the atmosphere. Allows recovery of largely intact spent rounds.
3. Depth: Minimum 12 ft 4 inches (3759 mm).
4. Height: 9 ft (2743 mm). Standard.
5. Height: 12 ft (3658 mm).
6. Height: 8 ft (2438 mm). Use for low ceiling situations.
7. Front Surface: Slopped.
8. Construction: Stepped steel bedplate, steel box tube support frame.
  - a. Self-supporting.
  - b. Mechanically fastened.
  - c. Upper holding bins shall be part of frame support assembly and not require overhead or rear wall support.
  - d. Upper frame shall support the armor plate upper slope sheet and extend no less than 5 ft (1524 mm) from the rear side of the trap assembly.
9. Upper Hopper Bin: Angled 3/8 inch (9.5 mm) AR500 armor plate slope sheet. Filled with replenishment rubber granulate (GranTex).
10. Bullet Trap Sidewalls: 3/8-inch (9.5 mm) AR500 armor plate.
  - a. AR500 Armor Plate. (Rifle): 3/8 inch (9,5 mm),
  - b. AR500 Armor Plate. (HD Pistol /Light Rifle use): 1/4 inch (6 mm).
  - c. HRS (Pistol use): 1/4 inch (6 mm).
  - d. Height: 8 ft (2438 mm).
  - e. Depth: To match the depth of the bullet trap rubber.
  - f. Seams: Vertical only.
11. Rubber Granules: GranTex.
  - a. Chopped rubber, predominately free of cording, threads, steel belting pieces and cotton fibers. Nominal Rubber Size: 7/8 inch (22 mm).
  - b. Captures fired rounds with little or no fragmentation or back-splatter.
  - c. Fire retardant treated with treatment that meets ASTM E108 Class A standards.
  - d. Meets ASTM E84 Class A requirements for flame spread and smoke development.
12. Bed Plate: 10-gauge steel, in a deep stepped configuration. Provides a safety barrier.
13. Impact Area Step Depth: Minimum 24 inches (610 mm).
14. Back-Up Safety Bin: Internal, separately enclosed, conveyor belt faced, rubber granule filled. Minimum 10 inches (254 mm) depth.
15. Capacity:
  - a. Primary Impact Area: Minimum 8 cu ft (227 liters) per section.
  - b. Replenishment Bin: Minimum 19 cu ft (538 liters) per section.
  - c. Back-Up Safety Bin: Minimum 10 cu ft (283 liters) per section.
16. Finish: Primed and painted.

## 2.3 SHOOTING STALLS

- A. Basis of Design: Model SafeZone Shooting Stalls as manufactured and supplied by InVeris Training Solutions.
  - a. Black.
2. Pistol Rated:
  - a. Maximum Bullet Velocity: 1485 ft per sec (453 m per sec).
  - b. Maximum Bullet Energy: 1175 ft-lbs. (1593 Nm).
  - c. Ballistic Rating, UL 752: Level 3.

3. Rifle Rated:
  - a. Maximum Bullet Velocity: 3025 ft per sec (922 m per sec).
  - b. Maximum Bullet Energy: 3048 ft-lbs. (4133 Nm).
  - c. Ballistic Rating, UL 752: Level 8.
4. Depth: 48 inches (1219 mm).
5. Features:
  - a. Swing down shooter's shelf with a resilient surface, raised edges to prevent accidental drop off, and a recessed tray area.
  - b. Acoustical blast shield extends to further shelter adjacent shooters.
  - c. Site light illuminates the stall interior.
  - d. Audio and visual communication systems.
  - e. Side shelf with accessory hooks.
  - f. Red/blue light for law enforcement training.
  - g. Wing gate barricade for standing strong and weak hand shooting.
  - h. Full height gate barricade.
  - i. Lighting: Recessed LED lights provide dimmable lighting for each stall.
  - j. Blast Shield: adjacent shooter muzzle blast protection.
  - k. Red/blue light for law enforcement training.
  - l. Shooter's bench with hooks to keep personal items off the floor.
  - m. ADA Compliant adjustable bench heights.
  - n. Lane Marker: Illuminating each shooting lane with a lane marker and corresponding lane number.

## 2.4 BAFFLES AND GUARDS

- A. Basis of Design: Air-Space Baffle, Model CB4 and Containment Ceiling, Model SC12, Re-Directive Guard, Model RG as manufactured and supplied by InVeris Training Solutions.
  1. Description: Baffles and Ceilings are comprised of mixed layered panels strategically engineered to contain a misdirected round via the wood facing, containing them within the air space chamber after striking the steel backing plate. Re-guards are bare steel panels typically used at the bullet trap end of the range.
  2. Material: 3/8 inch (9.5 mm) thick, AR500 steel.
  3. Features:
    - a. Minimizes bullet splatter from exiting the panel or returning to the open range area.
    - b. Ceiling, lights, ducts, pipes, and range equipment are protected downrange by a series of angled air- space baffles.
    - c. Shelters the ceiling area and redirects rounds toward the bullet trap.
    - d. Suspended the ceiling, at prescribed angles to the floor, starting at the firing line and extending downrange at the distance and locations as indicated on the drawings.
  4. Pistol Rated.
  5. Rifle Rated.
  6. Rubber Air-Space Enclosure Guard: Model EG, utilized for the furthest downrange panels nearest the rubber bullet trap.
  7. Steel Re-directive Guard: Model RG, utilized for the furthest downrange panels nearest the rubber bullet trap.
  8. Baffles and ceiling panels utilizing internal lumber frames and wooden 1/2 inch (013 mm) facings to be Fire Rated, Treated lumber.
  9. Acoustic Material: Acoustical material applied to the panel surfaces to assist in noise reduction.
  10. Approved Products: Troy Board / Sonex / PEPP - Flame Spread - 5 or less (ASTM E84) / Smoke -0 (ASTM E84)

- B. Basis of Design: Steel Light Cove Guard, Model JR7 as manufactured and supplied by InVeris Training Solutions.
  - 1. Description: Utilized for ranges that have a smooth, flush concrete ceiling structure. Protects the light fixtures, pipes, columns, and other ceiling obstructions.
  - 2. Material: 3/8 inch (9.5 mm) thick, AR500 steel.

## 2.5 TARGET SYSTEMS

- A. Basis of Design: XWT Wireless Monorail retrievable Target Carrier as manufactured and supplied by InVeris Training Solutions.
  - 1. Description: The next level of innovative range products available from InVeris Training Solutions. The quiet, smooth, low maintenance wireless carrier is easily operated and programmable, essential for successful training and usability.
  - 2. Features:
    - a. Easily programmable through a wireless controller, allowing uncomplicated intuitive screen operation.
    - b. Targets are locally controlled using the Lane Controller or from a control room area using the Primary Master Control Computer.
    - c. Programmable maneuvers and scenarios for skill set development and effective training.
    - d. Speed control options provide Advance and Retreat training exercises.
    - e. Basic and advanced user interfaces support the operator's preferred courses of fire.
    - f. Moves along a rail system, powered by an internal direct drive, dual motor system, with anti-static wheels for quieter, smoother operation.
    - g. Unique closed track design provides smooth target transportation.
    - h. Does not collect lead fragments, casings, and other debris.
    - i. No drive cables or pulleys to break or replace.
    - j. No bulky and noisy drive motors above the shooters head.
    - k. No track mounted power feed rails or wires to be impacted and damaged.
    - l. Closed track design so brass and debris does not interfere with target operation.
    - m. Includes 3/8 inch (9.5 mm) AR500 Front Armor Plate Prow.
    - n. Uses batteries with a positive locking battery connection and ergonomic battery placement and replacement.
    - o. New charging and docking system improved contact design for faster and more reliable charging.
    - p. Programmable distraction lighting integrates red, blue, and white LED target lighting, with muzzle flash simulation.
    - q. Chassis features a side cover designed for wheel overhead protection and the prevention of brass drivetrain damage.
    - r. Anti-static wheels eliminate the need for grounding hardware and reduces ESD challenges.

## 2.6 AUDIO AND VISUAL COMMUNICATION SYSTEMS

- A. Basis of Design: Remote Audio Communication as manufactured and supplied by InVeris Training Solutions.
  - 1. Description: Allows the range operator to call, listen, and converse with an individual shooter, a select group, or all shooters in unison by simply pressing the selector button on the master station. The operator can view the shooter via a video feed, allowing real-time feedback and response time for calls to master control.

2. Master Station Console: Contains a channel selection panel, a talk or listen release switch, and an all-call button and volume controls for outgoing and incoming communications.
3. Audio: Open voice speaker.
4. Audio: Handset to provide listening privacy and diminish background noise.
5. Call tone alerts the shooter of a transmission from the range operator, and the shooter responds simply by speaking.
6. Shooter momentarily depresses the call button on the terminal to contact the range operator.
7. Channels: 10/20/30/40
8. Features:
  - a. Ability to mix and match up to 11 components to create a customized communication solution.
  - b. Viewing visitors with CCTV cameras while speaking through the intercom.
  - c. Hands-free communication and push-to-talk operation for ease and simplicity.
  - d. LED lights and call tones at the master station specify which door or sub-station is calling.
  - e. Option to call one station at a time or call all stations at once.
  - f. Announcements can be heard throughout your facility with installation of indoor or outdoor speakers.

## 2.7 RANGE CONTROLS

- A. Basis of Design: RangeMaster 9000, RM9K as manufactured and supplied by InVeris Training Solutions.
  1. Description: An easy to use range control system offering instructors and range personnel the ability to write, store and run training scenarios. These scenarios can also be downloaded to the individual control units at the firing line or to another controller.
  2. Features:
    - a. Scenario files are easily retrieved and launched, with vivid display of real time range target conditions.
    - b. Targets are directed to initiate a command to travel, conceal, expose, or edge.
    - c. Displays all target locations, presentations, and other optional features via icons of changing colors and images on the computer screen.
    - d. Targets are shown in increments of feet, yards, or meters.
    - e. Can control any, all, or a combination of lanes with the simple click of the mouse with our Lane Manager software.
    - f. Displays the status of all lane ICU batteries on a single page and delivers a pop-up on the browser if the lane battery gets low.
    - g. Sets a time limit on the lane ICU. A configurable countdown timer flashes when remaining time drops below five minutes.
    - h. Displays a pop-up on the Lane Manager page when lane time drops below the five-minute limit.
    - i. Triggers the ICU into lock-down mode when time runs out, only allowing the carrier to come home.
    - j. Displays a Help button on the ICU, enabling a pop-up notification display. The Help notification can be enabled or disabled.
    - k. Turns on a light above the shooter's booth when the Help button is enabled. This light is controlled via a Wi-Fi enabled smart switch.
    - l. Works in administrative mode, allowing the range operator to reboot the ICU's individually or all ICU's simultaneously and upgrade the ICU firmware

individually or all ICU's simultaneously.

- B. Basis of Design: RangeMaster 10K, RM10K as manufactured and supplied by InVeris Training Solutions.
  - 1. Description: Combines advanced wireless and touch screen technologies for convenience and flexibility in range control operations.
  - 2. Features:
    - a. Complete system control is managed through portable tablet computers, allowing personnel to leave the control room while maintaining complete control of the range.
    - b. The control and portability equate to increased productivity, as range instructors devote attention to firearms instruction rather than range management from the confines of a control room.
    - c. Touchscreen controller utilizes the latest technology in an intuitive, easy-to-navigate manner.
    - d. Range personnel may choose from multiple options on one screen, including the menu bar, target commands and arrangement.
    - e. Accepted commands include friend, foe, and edge.
    - f. Random commands direct the target to present a complete, unexpected turn to the right or left, in increments of up to 360 degrees, allowing for real life scenarios and enhanced target training.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Do not begin installation until exterior locations, structure and installing surfaces have been properly prepared.
- B. Verify that all supports, and other adjoining conditions have been installed and prepared in accordance with the Drawings.
- C. If structure and installing surfaces preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### **3.3 INSTALLATION**

- A. Install all equipment in accordance with manufacturer's instructions.
- B. Equipment shall be assembled entirely by mechanical fasteners. No on-the-job cutting or welding is permitted.
- C. Equipment shall be mounted to the floor or suitable concrete surfaces as shown on the Drawings.
- D. All metal parts not otherwise finished shall be primed or painted.

### **3.4 FIELD QUALITY CONTROL**

- A. Field Inspection: Coordinate field inspection in accordance with appropriate sections in Division 01.
- B. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.

**3.5 ADJUSTING**

- A. Test the functionality of all control systems, safety systems, target systems and control systems.
- B. Correct any deficiencies and replace any equipment not operating as required.

**3.6 CLEANING AND PROTECTION**

- A. Clean products in accordance with the manufacturer's recommendations.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 116723

**SECTION 122413 - ROLLER WINDOW SHADES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Roller shades for manual operation and accessories.
  - 2. Shade fabric.
- B. Related Requirements:
  - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
  - 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material.
- C. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Fabricator of products.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

**1.8 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity

conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design: Product selections are based upon the primary manufacturer below. Provide basis of design product or comparable product of a listed manufacturer as submitted to and approved by Architect prior to bid.
  1. MechoShade, Mecho/5 System.
- B. Acceptable Manufacturers:
  1. Draper
  2. Hunter Douglas
- C. Source Limitations: Obtain roller shades from single source from single manufacturer.

### **2.2 MANUALLY OPERATED SHADES**

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
  1. Bead Chains: Nickel-plated metal.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Clip, jamb mount.
  2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
    - a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criteria are more stringent.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  1. SH-1: Single Roller.
  2. SH-2: Double Roller
  3. Roller Drive-End Location: Right side of inside face of shade
  4. Direction of Shadeband Roll: Regular, from back of roller.
  5. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
  1. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.
    - a. Light-Filtering Fabric: Room-side of opening.



- b. Room-Darkening Fabric: Glass-side of opening.
- D. Mounting: Ceiling mounted.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Shadebands:
  - 1. Shadeband Material: Light-filtering fabric.
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material.
    - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
  - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped.
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches.
  - 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
    - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches.
  - 3. Endcap Covers: To cover exposed endcaps.
  - 4. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
    - a. Closure-Panel Width: 2 inches.
  - 5. Installation Accessories Color and Finish: As selected from manufacturer's full range

### 2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
  - 1. Source: MechoSystems
  - 2. Type: EuroTwill 6000 Series
  - 3. Roll Width: 118 inches
  - 4. Openness Factor: 3% open
  - 5. Color: 6018 Stone
  - 6. Notes: Manual with cord control
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
  - 1. Source: MechoSystems
  - 2. Type: Chelsea Blackout 0250 Series Opaque
  - 3. Thickness: 0.018 inches thick
  - 4. Weight: 11.50 oz. per square yard
  - 5. Roll Width: 126 inches
  - 6. Color: 0258 Napa

## **2.4 ROLLER SHADE FABRICATION**

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
  - 1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
  - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than **1:4**, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 ROLLER SHADE INSTALLATION**

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions and per the design intent in the drawings. Provide shims to allow for appropriate installation.

### **3.3 ADJUSTING**

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### **3.4 CLEANING AND PROTECTION**

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 122413

**SECTION 125000 - FURNITURE****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Systems Furniture
- B. Detention Furniture

**1.2 RELATED SECTIONS**

- A. Section 011000 "Summary of Work"
- B. Section 033000 "Cast-in-Place Concrete"
- C. Section 055000 "Metal Fabrication"
- D. Section 260500 - Common Work Results for Electrical

**1.3 SUBMITTALS**

- A. Submit under provisions of Section 013300 - Submittals.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Storage and handling requirements and recommendations.
  - 3. Installation methods.
- C. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- D. Verification Samples: For each finish product specified, two samples, representing actual product and finish.

**1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Minimum 5 year experience manufacturing similar products.
- B. Installer Qualifications: Minimum 2 year experience installing similar products.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect.
  - 2. Do not proceed with remaining work until workmanship is approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work.

**1.5 PRE-INSTALLATION MEETINGS**

- A. Convene minimum two weeks prior to starting work of this section.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.
- B. Handling: Handle materials to avoid damage.

**1.7 PROJECT CONDITIONS**

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

**1.8 SEQUENCING**

- A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Systems Furniture:
  1. Basis of Design: Product selections are based upon the primary manufacturer below.
    - a. Missouri Vocational Enterprises (MVE) – Refer to furniture schedule in drawings for selections.
  2. Components:
    - a. Desks
    - b. Tables
    - c. Shelving
    - d. Storage
    - e. Movable units
    - f. Tack surfaces
    - g. Power and data outlets
- B. Detention Furniture:
  1. Basis of Design: Product selections are based upon the primary manufacturer below.
    - a. Missouri Vocational Enterprises (MVE) – Refer to furniture schedule in drawings for selections.
- C. Existing Furniture (R):
  1. Typical offices, storage areas, meeting and conference rooms, etc:
    - a. In one phase, the Contractor is responsible to remove/salvage existing furniture that is to be relocated. Contractor is responsible for installing in new building.

2. Radio Room:
  - a. When new building is ready to occupy the Contractor is responsible to remove/salvage existing furniture that is to be relocated. Contractor is responsible for installing in new building.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

#### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

#### **3.3 INSTALLATION**

- A. Install in accordance with manufacturer's instructions and in proper relationship with adjacent construction. Test for proper operation and adjust until satisfactory results are obtained.

#### **3.4 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 125000

# PROJECT MANUAL

## *Volume 2*

*Construct New Headquarters*

*Troop A Headquarters, MSHP*

*Lee's Summit, Missouri*

Designed By: Gastinger Walker  
817 Wyandotte  
Kansas City, MO 64105

Date Issued: August 1, 2023

Project No.: R2219-01

STATE of MISSOURI

OFFICE of ADMINISTRATION  
Facilities Management, Design & Construction

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## SECTION 210500 - BASIC FIRE SUPPRESSION REQUIREMENTS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

## 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
  - 1. Plumbing Work: Refer to Section 220500 "Basic Plumbing Requirements".
  - 2. Heating Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 3. Air Conditioning and Ventilating Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 4. Temperature Control Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 5. Fire Protection Work shall include, but is not necessarily limited to:
    - a. Furnish and install a new fire protection service to the building including backflow preventer as required by Code.
    - b. Furnish and install a complete wet pipe sprinkler system for areas noted on the drawings.
    - c. Furnish and install a complete dry pipe sprinkler system for areas noted on the drawings.
    - d. Furnish and install all items listed on the Fire Protection Material List.
    - e. Furnish all hydraulic calculations and working sprinkler drawings.
    - f. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    - g. Complete all applicable tests, certifications, forms, and matrices.
  - 6. Testing, Adjusting, and Balancing Work: Refer to Section 230500 "Basic HVAC Requirements".

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

- 1. "Mechanical Contractors" refers to the following:
  - a. Plumbing Contractor.
  - b. Heating Contractor.
  - c. Air Conditioning and Ventilating Contractor.
  - d. Temperature Control Contractor.
  - e. Fire Protection Contractor.
  - f. Testing, Adjusting, and Balancing Contractor.
- 2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
- 3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
- 4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
- 5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
  - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
- 6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
- 7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

## B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

## C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
  - a. Computer Room Air Conditioning Units.
  - b. Condensing Units.
  - c. Gas Trains.
  - d. Package Air Handling Units.
  - e. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
  - a. Wiring of all devices needed to make the Temperature Control System functional.
  - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.

- c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
- 5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

- 1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
- 2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
- 3. Provides motor control and temperature control wiring, where so noted on the drawings.
- 4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
- 5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
- 6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

#### 1.4 COORDINATION DRAWINGS

A. Definitions:

- 1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
- 2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.

- a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
  2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    - a. Scale of drawings:
      - 1) General plans: 1/4 Inch = 1'-0" (minimum).
      - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
      - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
  2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
  3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
  4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

## D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.5 QUALITY ASSURANCE

## A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.
- B. Qualifications:
1. Only products of reputable manufacturers are acceptable.
  2. All Contractors and subcontractors shall employ only workers skilled in their trades.
- C. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the City of Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
  2. Conform to all State Codes.
  3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
  4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
  5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
  6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
  7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
  2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
  3. Pay all charges for permits or licenses.
  4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
  5. Pay all charges arising out of required inspections by an authorized body.
  6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
  7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
  2. Comply with all utility company requirements.
  3. Make application for and pay for fire protection water service connection.

## F. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

## G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

## H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.



## 1.6 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 05 03	Fire Seal Systems
21 05 29	Hangers and Supports
21 05 48	Vibration Isolation Equipment
21 05 53	Mechanical Identification
21 23 00	Fire Suppression Systems

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer
- d. Contractor and subcontractors' names and addresses
- e. Supplier and manufacturer's names and addresses
- f. Division of work (e.g., plumbing, heating, ventilating, etc.)
- g. Description of item submitted (using project nomenclature) and relevant specification number
- h. Notations of deviations from the contract documents
- i. Other pertinent data
- j. Provide space for Contractor's review stamps

3. Composition:

- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
- b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
- c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
  - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 21 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.7 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  1. Fire Seal Systems
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

#### 1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

#### 1.9 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

#### 1.10 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

#### 1.11 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

#### 1.12 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
  - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
  - 2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.
- B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried utilities. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand CA6 to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.

7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
  - a. Pipe wall penetrations are sealed.
  - b. Pipe identification is installed.
  - c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.

3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection report by the State Fire Marshal of the fire protection system.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div21.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.



6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Maintenance of equipment.
  3. Start-up procedures for all major equipment.
  4. Explanation of seasonal system changes.
  5. Description of emergency system operation.

- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  - 1. Sprinkler System(s) - 2 hours.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
  - 1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
  - 2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM STARTING AND ADJUSTING

- A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 01 requirements.

- B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible fire protection drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2. All pumps operating and balanced.
- 3. Fire protection system operational.
- 4. Pipes labeled.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 210500

**SECTION 210503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. The Building Officials and Code Administrators National Building Code
- J. 2018 International Building Code
- K. NFPA 5000 - Building Construction Safety Code

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

## 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  - 1. Review foreseeable methods related to firestopping work.
  - 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

- B. Manufacturers:
1. 3M; Fire Protection Products Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Dow Corning Corp.
  10. Fire Trak Corp.
  11. International Protective Coating Corp.

## 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:
1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:
    - a. F Rating = Floor/Wall Rating
  2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:
    - a. F Rating = Wall Rating
- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

### **3.2 INSTALLATION**

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### **3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."



2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### **3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 210503

**SECTION 210529 - FIRE SUPPRESSION SUPPORTS AND ANCHORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

**1.2 QUALITY ASSURANCE**

- A. Support Sprinkler Piping in conformance with NFPA 13.

**1.3 REFERENCES**

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- D. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
- E. NFPA 13 - Standard for the Installation of Sprinkler Systems.

**1.4 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 210500.

**1.5 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS**

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

**PART 2 - PRODUCTS****2.1 HANGER RODS**

- A. Hanger rods for single rod hangers supporting steel, copper, and CPVC piping shall conform to the following:

Pipe Size	Rod Size
4" and smaller	3/8"
5" 6", and 8"	1/2"
10"	5/8"
12"	3/4"

- B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

## 2.2 PIPE HANGERS AND SUPPORTS

### A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, 69, 89, and 127 (where applicable).

## 2.3 FOUNDATIONS, BASES, AND SUPPORTS

### A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

### B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
4. Equipment requiring bases is as follows:
  - a. Air Compressor
  - b. Dry Pipe System Cabinet

### C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

- D. Grout:
1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
  2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
  3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

#### **2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS**

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

#### **2.5 PIPE SLEEVES**

- A. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- B. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.
- C. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- D. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- E. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- F. Wall Seals ("Link-Seals"):
  1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
  2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve or thermoplastic with integral water seal and textured surface.
  3. Sleeves shall be at least 2 pipe sizes larger than the pipes.

4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

6. Manufacturers:
  - a. Thunderline Corporation "Link-Seals"
  - b. O-Z/Gedney Company
  - c. Calpico, Inc.
  - d. Innerlynx
  - e. Metraflex Company (cold service only).

## 2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

## 2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

**PART 3 - EXECUTION****3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS****A. General Installation Requirements:**

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

**B. Supports Requirements:**

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

**C. Pipe Requirements:**

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

**D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:**

1. Loads of 100 lbs or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.

- b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  - 3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  - 4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall in no case exceed the following:
- 1. Steel (All steel pipe unless otherwise noted):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 12'-0"
      - 2) 1-1/2" & larger: 15'-0"
  - 2. Steel (Schedule 40 lightweight alternative):
    - a. Maximum Spacing:
      - 1) 3" & under: 12'-0"
  - 3. Hard Drawn Copper:
    - a. Maximum Spacing:
      - 1) 1" & under: 8'-0"
      - 2) 1-1/4" to 1-1/2": 10'-0"
      - 3) 2" to 3": 12'-0"
      - 4) 3-1/2" & larger: 15'-0"
- I. Installation of hangers shall conform to MSS SP-58, 69, 89, and applicable NFPA standards.

END OF SECTION 210529

**SECTION 210548 - FIRE PROTECTION VIBRATION ISOLATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Bases.
- B. Vibration Isolation.
- C. Flexible Connectors.

**1.2 SUBMITTALS**

- A. Submit shop drawings per Section 210500 and the Vibration Isolation Submittal Form at the end of this section.
- B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
- C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.
- D. Isolator submittals shall include:
  - 1. Equipment served
  - 2. Type of Isolator
  - 3. Load in Pounds per Isolator
  - 4. Recommended Maximum Load for Isolator
  - 5. Spring Constants of Isolators (for Spring Isolators)
  - 6. Load vs. Deflection Curves (for Neoprene Isolators)
  - 7. Specified Deflection
  - 8. Deflection to Solid (at least 150% of calculated deflection)
  - 9. Loaded (Operating) Deflection
  - 10. Free Height
  - 11. Loaded Height
  - 12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
  - 13. Materials and Coatings
  - 14. Spring Diameters
- E. Make separate calculations for each isolator on equipment where the load is not equally distributed.
- F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

**PART 2 - PRODUCTS****2.1 BASIC CONSTRUCTION AND REQUIREMENTS**

- A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.



- B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.
- C. The lateral to vertical stiffness ratio ( $K_x/K_y$ ) of spring isolators shall be between 0.8 and 2.0.
- D. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use. Bolts, nuts and washers shall be zinc electroplated. All damage to coatings shall be field repaired with two coats of zinc rich coating.
- E. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.
- F. All isolators, except M1, shall have provision for leveling.

## 2.2 MOUNTINGS

- A. Type M3:
  1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
  2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.
  3. All mountings shall have leveling bolts.
  4. Manufacturers:
    - a. Mason "SLFH"
    - b. Kinetics "FDS"
    - c. Amber/Booth "SW-3, 4", 5" or 6"
    - d. Vibration Eliminator Co. "OST"

## 2.3 HANGERS

- A. Type H1:
  1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
  2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
  3. Provide hangers with end connections as required for hanging ductwork or piping.
  4. Manufacturers:
    - a. Mason "HD"
    - b. Kinetics "RH"
    - c. Aeroflex "RHD"
    - d. Vibration Eliminator Co. "IC/3C/3CTD"
    - e. Vibro Acoustics "RH"

## 2.4 BASES

- A. Type B1:
1. Rectangular structural steel bases.
  2. All perimeter members shall be beams or channels with minimum depth of 10% of the longest base dimension or 14" maximum if rigidity is acceptable to the equipment manufacturer.
  3. Use height saving brackets, unless noted otherwise.
  4. Manufacturers:
    - a. Mason "WF"
    - b. Kinetics "SBB"
    - c. Aeroflex
    - d. Vibration Eliminator Co. "AF"

## 2.5 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

- A. Type FC1:
1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
  2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.
  3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
  4. Connectors up to 2" size may have threaded ends.
  5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
  6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
  7. Manufacturer:
    - a. Metraflex "Double Cable-Sphere"
    - b. Minnesota Flex Corp.
    - c. Mercer "200 Series"
    - d. Twin City Hose "MS2".

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Provide vibration isolation as indicated on the drawings and as described herein.
- C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.
- D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

- E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.
- F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as pipes supported on a strut rack.

### **3.2 PIPE ISOLATION**

- A. The first three hangers from vibration-isolated equipment shall be type H1.

### **3.3 VIBRATION ISOLATION SCHEDULE**

- A. Air Compressor:
  - 1. Base Type: NA
  - 2. Isolator Type: M1
  - 3. Static Deflection: NA
  - 4. Flexible Connections: NA

END OF SECTION 210548

**SECTION 210553 - FIRE SUPPRESSION IDENTIFICATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Identification of products installed under Division 21.

**1.2 REFERENCES**

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM B-1, B-3, and B-8 for copper conductors.
- C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 - 2kv Cables.
- D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 210500. Include list of items identified, wording, letter sizes, and color coding.
- B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

**PART 2 - PRODUCTS****2.1 ACCEPTABLE MANUFACTURERS**

- A. 3M
- B. Emedco
- C. Seton
- D. W.H. Brady

**2.2 MATERIALS**

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

- B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

- C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- E. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
- F. Tracer Wire:
  1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
  2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
  3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
  1. All valves (except shutoff valves at equipment) shall have numbered tags.
  2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  6. Number all tags and show the service of the pipe.
  7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
  1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.

3. Stencil Painted Pipe Markers:
  - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
  - b. Apply primer on non-insulated pipes before painting.
  - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
  - a. At each valve.
  - b. On both sides of walls that pipes penetrate.
  - c. At least every 20 feet along all pipes.
  - d. On each riser and each leg of each "T" joint.
  - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

### 3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text shown as follows, regardless of which method or material is used:

1. FIRE PROTECTION WATER: White lettering; red background
2. SPRINKLER WATER: White lettering; red background
3. Tracer Wire - Water Pipe Lines: White lettering; green background
4. Tracer Wire - All other buried types: White lettering; green background

- B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION 210553

**SECTION 211302 - FIRE PROTECTION SYSTEMS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Pipe, Fittings, Valves, and Connections for Fire Protection System.
- B. Wet-Pipe Sprinkler System.
- C. Pre-action Sprinkler System.

**1.2 QUALITY ASSURANCE**

- A. Welding Materials and Procedures: Conform to ASME Code.
- B. Equipment and Components: Bear UL label or marking.
- C. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
- D. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

**1.3 REFERENCES**

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Butt-Welding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- G. ANSI/ASME B16.25 - Butt-Welding Ends.
- H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- I. ANSI/ASME Section 9 - Welding and Brazing Qualifications.
- J. ANSI/ASTM A47 - Malleable Iron Castings.
- K. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- L. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.



- N. ASME - Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.
- O. ASTM A153 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- P. AWS A5.8 - Brazing Filler Metal.
- Q. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.
- R. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- S. IBC - International Building Code.
- T. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.
- U. NFPA 101 - Life Safety Code,
- V. NFPA 13 - Standard for the Installation of Sprinkler Systems.
- W. NFPA 13D - Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes.
- X. NFPA 13R - Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.
- Y. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- Z. UL - Underwriter's Laboratory Fire Protection Equipment Directory.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings per Section 210500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
- B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
- C. Submit detailed working drawings and obtain review of them in the following order:
  - 1. State Fire Marshal/Authority Having Jurisdiction
  - 2. Owner's Insurance Company
  - 3. Architect/Engineer
  - 4. Local Fire Department
  - 5. Architect/Engineer
- D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.
- E. Submit dry-pipe calculations including water delivery time and air supply refill defined in NFPA 13. Water delivery time and air supply shall meet the requirements set forth in NFPA 13.

- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- G. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.

#### **1.5 EXTRA STOCK**

- A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store valves and sprinklers in shipping containers, with labels in place.
- B. Provide temporary protective coating on iron and steel valves.
- C. Maintain temporary end caps and closures in place until installation.

#### **1.7 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS**

- A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

#### **1.8 SYSTEM DESCRIPTION**

- A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:
  - 1. Wet pipe sprinkler system(s)
  - 2. Pre-action sprinkler system(s)
- B. Sprinkler systems shall be designed and installed according to the following standard(s):
  - 1. NFPA 13 - Standard for the Installation of Sprinkler Systems
- C. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes, and Owner's insurance company in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.
- D. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.
- E. The water supply source for this project is the following:
  - 1. Public waterworks system.

2. The system design shall be based on water supply information provided on the contract drawings. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.
  3. System design shall be based on the following water supply information. Supply shall be presumed to be at the point of connection to existing water supply infrastructure unless noted otherwise. The Fire Protection Contractor is responsible to verify this information and conduct all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.
    - a. Date of Test:08/01/2022
    - b. Test Conducted By: Lee's Summit, Missouri Water Utility
    - c. Static Pressure: 81 psig
    - d. Residual Pressure: 64 psig
    - e. Flow at Residual Pressure: 2000 GPM
  4. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:
    - a. 5 psig
- F. Coordinate with Plumbing Contractor for installation of a floor drain with collection funnel below the backflow preventer.

#### **1.9 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 210500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

#### **1.10 OPERATION AND MAINTENANCE DATA**

- A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

#### **1.11 JOB CONDITIONS**

- A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.

### **PART 2 - PRODUCTS**

#### **2.1 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS**

- A. Piping - 2" and Under (Steel Pipe):
  1. Design Pressure: 175 psig

2. Pipe: Lightweight Schedule 40 alternative, black steel, ASTM A135, ASTM A795. corrosion resistance ratio (CRR) shall be greater than 1.0 per UL Directory Listing, UL/FM. Inner wall shall be coated with an anti-MIC (Microbiologically Influenced Corrosion) coating.
3. Schedule 40/Lightweight Schedule 40 Joints: Threaded.
4. Fittings:
  - a. Threaded:
    - 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.4ASTM A153.
    - 2) Malleable iron, Class 150, black, UL, ANSI/ASME B16.3ASTM A153.
    - 3) Ductile iron, Class 150, black, UL, ANSI/ASME B16.3ASTM A153.
  - b. Grooved:
    - 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
  - c. Flanged:
    - 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.
5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 40, black steel ASTM A53, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Joints: Grooved.
4. Fittings:
  - a. Grooved:
    - 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
  - b. Flanged:
    - 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.

## 2.2 PIPE AND FITTINGS - DRY PIPE SPRINKLER SYSTEMS

A. Piping - 2" and Under (Steel):

1. Design Pressure: 175 psig Pipe: Schedule 40, black steel, ANSI/ASTM A153, ASTM A795, UL/FM. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
2. Joints: Threaded or roll grooved.
3. Fittings:
  - a. Threaded:

- 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.4ASTM A153.
  - 2) Malleable iron, Class 150 black, UL, ANSI/ASME B16.3ASTM A153.
  - 3) Ductile iron, Class 150, black, UL, ANSI/ASME B16.3ASTM A153.
- b. Grooved:
- 1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts. Provide flush gap style gasket. Lubricate gasket according to manufacturer recommendations.
- c. Flanged:
- 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.
4. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.
- B. Piping - 2-1/2" and Above:
1. Design Pressure: 175 psig
  2. Pipe: Schedule 10, black steel ASTM A135, ASTM A795, UL.
  3. Joints: Roll grooved.
  4. Fittings:
    - a. Grooved:
      - 1) Ductile iron housing ASTM A-536 Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
    - b. Flanged:
      - 1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1ASTM A153.

### **2.3 PIPE AND FITTINGS - PREACTION SYSTEM**

- A. Refer to Article 2.2 PIPE AND FITTINGS - DRY PIPE SYSTEMS.

### **2.4 PIPE AND FITTINGS - WET STANDPIPE SYSTEM**

- A. Refer to Article 2.1 PIPE AND FITTINGS - WET PIPE SYSTEMS.

### **2.5 PIPE AND FITTINGS - DRY STANDPIPE SYSTEM**

- A. Refer to Article 2.2 PIPE AND FITTINGS - DRY PIPE SYSTEMS.

### **2.6 VALVES**

- A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.
- B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

**2.7 BACKFLOW PREVENTERS**

- A. Provide backflow preventers as required by code and as specified on the drawings.

**2.8 EQUIPMENT**

- A. Equipment shall be as scheduled on the drawings.

**2.9 RISER LABELING AND IDENTIFICATION**

- A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:
  1. Installation contractor
  2. Date installed
  3. Riser location
  4. Number of sprinklers
  5. Basis of design (density GPM/ft<sup>2</sup> and area of coverage ft<sup>2</sup>)
  6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
  7. Hose stream allowance (GPM).
  8. Occupancy classification
  9. Commodity classification (If applicable)
  10. Maximum storage height (if applicable)

**2.10 PIPE LABELING AND IDENTIFICATION**

- A. All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe. The manufacturer pipe marking shall be visible on every piece of pipe over 2 ft (600 mm) long. Manufacturer pipe identification shall include the manufacturer's name, model designation, and/or schedule. Provide additional identification as described in Section 210553.

**PART 3 - EXECUTION****3.1 INSTALLATION - PIPING**

- A. General Installation Requirements:
  1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
  2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
  3. Die cut screw joints with full cut standard taper pipe threads.
  4. Coat threads with pipe joint compound or wrap with Teflon tape.
  5. Locate piping to minimize obstruction of other work.
  6. Route piping in concealed spaces above finished ceiling.
  7. Use full and double lengths of pipe wherever possible.
  8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
  9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
  10. Comply with manufacturer's installation instructions.

B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

C. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 210529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
  - a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
  - b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

G. Dry Pipe System:

1. All fire protection piping within rooms served by preaction systems shall be downstream of dry pipe valve. Wet piping upstream of these devices shall not be installed above these rooms.
2. Refrigerated spaces served by dry pipe valves shall have a 30" easily removable section of pipe located immediately upstream and downstream of pipe entrance to a refrigerated space per NFPA 13. Piping shall be pitched back toward the dry pipe assembly. Air intake for compression devices serving preaction or dry pipe systems shall be from the refrigerated area.

### 3.2 INSTALLATION - VALVES

- A. Install gate valves with stems upright or horizontal, not inverted.

**B. Backflow Preventer:**

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.
4. Provide monitor switches on all shutoff valves.

**C. Dry Pipe Valve:**

1. Install dry pipe valve in heated area to prevent mechanical damage.
2. Provide all required trim and accessories for a fully functioning dry pipe valve system.

**D. Shutoff Valve:**

1. Install buried shutoff valves in valve boxes. Provide post indicators.
2. Provide drain valves at main shutoff valves, low points of piping and apparatus.
3. Provide monitor switches on all shutoff valves.

**3.3 INSTALLATION - EQUIPMENT****A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.****B. Fire Department Connection:**

1. Locate fire department connection as approved by the local fire department with sufficient clearance from walls, obstructions, and adjacent Siamese connectors to allow full swing of fire department wrench handle.

**C. Horn and Strobe:**

1. Locate outside horn and strobe on building wall as shown on drawings.
2. Wire all horn and strobes, flow switches and supervisory switches to fire alarm system. All wiring shall be in conduit and meet the requirements of the electrical specifications.

**D. Test Valves:**

1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

**E. Sprinklers:**

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.



- F. Double Interlocked Preaction System:
  - 1. Provide all valves, switches, detectors and all wiring to devices from the alarm control panel.

### 3.4 SYSTEMS CLEANING AND TESTING

- A. General Requirement:
  - 1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.
- B. Underground Piping:
  - 1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
    - a. 390 gpm for 4" pipes.
    - b. 880 gpm for 6" pipes.
  - 2. Branches from existing or new underground mains to sprinkler risers shall be flushed out through two 2-1/2" hoses (with flow through open hose butts) attached to the riser with 4" temporary piping. Flushing through the drain of an alarm check or dry pipe valve is not acceptable.
- C. Interior Piping:
  - 1. Verify adequate water flow at the inspector's test connection.
  - 2. Flush all interior piping to remove scale and other foreign material before placing system into service.
  - 3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure. Test shall be performed with dry pipe valves in open position to prevent valve damage.
- D. Dry Piping:
  - 1. On dry-pipe systems, also test the interior piping with an air pressure of 40 psi for 24 hours. Pressure loss shall not exceed 1-1/2 psi in 24 hours with allowance made for temperature change. An odorant, such as oil of wintergreen, may be added to help locate leaks.
- E. Fire Alarm System:
  - 1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
  - 2. Adjust all monitor switches for proper operation.

END OF SECTION 211300

**SECTION 212300 - FIRE SUPPRESSION SYSTEMS****PART 1 - GENERAL****1.1 RELATED WORK**

- A. Section 210500 - Basic Fire Suppression Requirements.

**1.2 REFERENCES/REGULATORY REQUIREMENTS**

- A. All Applicable Local and State Codes and Standards.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 210500.
- B. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect products to prevent damage and exposure to moisture.

**PART 2 - PRODUCTS (Not Used)****PART 3 - EXECUTION****3.1 INSTALLATION**

- A. General Requirements:
  - 1. The Contractor shall have a minimum of five (5) years' experience in the installation of the described work within this specification section.
  - 2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- B. Piping Requirements:
  - 1. All internal surfaces of piping shall be cleaned thoroughly. After installation, piping to be flushed with water and nitrogen purged to remove any debris.
  - 2. All piping to be secured with UL listed pipe hangers. Hanger spacing per fire suppression system manufacturer's recommendations.

C. Nozzle Requirements:

1. All discharge nozzles shall be cleaned, dried, and reassembled with nozzle caps, prior to commissioning the system.
2. Discharge nozzle placement per fire suppression system manufacturer's recommendations.

END OF SECTION 212300

## SECTION 220500 - BASIC PLUMBING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
  - 1. Plumbing Work shall include, but is not necessarily limited to:
    - a. Furnish and install all items listed in the Plumbing Material List.
    - b. Furnish and install a new domestic water service to the building.
    - c. Furnish and install water meter and domestic water backflow preventer as required by Code.
    - d. Furnish and install a complete domestic water piping system including cold, hot, and hot water circulating piping within the building. Insulate all piping as specified.
    - e. Furnish and install complete gas piping system including all meter requirements.
    - f. Furnish and install water heaters.
    - g. Furnish and install a new fire protection service to the building including backflow preventer as required by Code.
    - h. Furnish and install makeup water connection to hydronic heating and/or cooling systems including reduced pressure principle type backflow preventer.
    - i. Furnish and install condensate drain piping from plumbing related equipment such as ice machines.
    - j. Furnish and install complete sanitary sewer and vent system.
    - k. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    - l. Complete all applicable tests, certifications, forms, and matrices.
  - 2. Heating Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 3. Air Conditioning and Ventilating Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 4. Temperature Control Work: Refer to Section 230500 "Basic HVAC Requirements".
  - 5. Fire Protection Work: Refer to Section 210500 "Basic Fire Suppression Requirements".

6. Testing, Adjusting, and Balancing Work: Refer to Section 230500 "Basic HVAC Requirements".

### 1.3 OWNER FURNISHED PRODUCTS

- A. The Owner will supply the following items for installation and/or connection by this Contractor:
  1. Project Base Bid: Auto-repair garage waste oil heater (transported from separate site). Provide new waste oil tank, associated controls and accessories.
  2. Project Base Bid: Radio equipment room server equipment and server rack assembly, including all associated packed in-row cooling equipment and heat containment equipment.
- B. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.
- C. This Contractor shall make all plumbing system connections shown on the drawings or as required for fully functional units.

### 1.4 ALTERNATES

- A. Auto repair garage waste oil heater WOH-1, waste oil storage tank, associated controls and accessories. Reference drawings for scheduled model and performance data.

### 1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

- A. Definitions:
  1. "Mechanical Contractors" refers to the following:
    - a. Plumbing Contractor.
    - b. Heating Contractor.
    - c. Air Conditioning and Ventilating Contractor.
    - d. Temperature Control Contractor.
    - e. Fire Protection Contractor.
    - f. Testing, Adjusting, and Balancing Contractor.
  2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
  3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
  4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
  - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
  - a. Boiler Feed Pumps.
  - b. Burners.
  - c. Condensate Return Pumps.
  - d. Condensing Units.
  - e. Gas Trains.
  - f. Package Air Handling Units.
  - g. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
  - a. Wiring of all devices needed to make the Temperature Control System functional.
  - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
  - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

- a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
  3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
  2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.



- a. Scale of drawings:
  - 1) General plans: 1/4 Inch = 1'-0" (minimum).
  - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
  - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
  - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
  - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.7 QUALITY ASSURANCE

### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards.
3. Conform to all State Codes.
4. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
5. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
6. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
7. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
8. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
9. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as sewer and water and gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

## H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

**1.8 SUBMITTALS**

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

## 1. Submittals List:

Referenced Specification Section	Submittal Item
22 05 00	Owner Training Agenda
22 05 13	Motors
22 05 29	Hangers and Supports
22 05 29	Prefabricated Curbs
22 05 53	Plumbing Identification
22 07 16	Plumbing Equipment Insulation
22 07 19	Plumbing Pipe Insulation
22 10 00	Plumbing Piping Systems and Valves
22 10 23	Natural Gas and Propane Piping Systems
22 10 30	Plumbing Specialties
22 11 23	Domestic Water Pumps
22 30 00	Plumbing Equipment
22 40 00	Plumbing Fixtures

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number

- f. Notations of deviations from the contract documents
  - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
- a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

- 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
    - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
    - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
  8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
  9. Reproduction of contract documents alone is not acceptable for submittals.
  10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
  11. Submittals not required by the contract documents may be returned without review.
  12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
  13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
  14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
  15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
  16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 22 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

### **1.9 EQUIPMENT SUPPLIERS' INSPECTION**

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  1. Fire Seal Systems
  2. Water Heaters
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

### **1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE**

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

**1.11 NETWORK / INTERNET CONNECTED EQUIPMENT**

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

**1.12 WARRANTY**

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

**1.13 INSURANCE**

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

**1.14 MATERIAL SUBSTITUTION**

- A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.



**PART 2 - PRODUCTS (Not Used)****PART 3 - EXECUTION****3.1 JOBSITE SAFETY**

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

**3.2 EXCAVATION, FILL, BACKFILL, COMPACTION****A. General:**

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

**B. Excavation:**

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

**C. Dewatering:**

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand CA6 to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.

2. Covering exterior walls, interior partitions and chases.
  3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe insulation is installed and fully sealed.
    - b. Pipe wall penetrations are sealed.
    - c. Pipe identification and valve tags are installed.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
  5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div22.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

#### C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Maintenance of equipment.
  3. Start-up procedures for all major equipment.
  4. Explanation of seasonal system changes.
  5. Explanation of Owner's Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  1. Domestic Hot Water System - 2 hours.
  2. All Domestic Water Systems operation, maintenance and flushing of all fixtures and dead legs - 2 hours.
  3. Domestic Water Pressure Booster System - 2 hours.
  4. Water Softener, Filtration and/or Purification System - 2 hours.
  5. Domestic Water Supplemental Treatment System - 2 hours.
  6. Medical Gas System(s) - 2 hours.
- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

- H. Operating Instructions:
1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### **3.7 SYSTEM STARTING AND ADJUSTING**

- A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### **3.8 RECORD DOCUMENTS**

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual invert and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### **3.9 PAINTING**

- A. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- B. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

### **3.10 ADJUST AND CLEAN**

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### **3.11 SPECIAL REQUIREMENTS**

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

### **3.12 UTILITY REBATE**

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
  - 1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2. All pumps operating and balanced.
- 3. All plumbing fixtures installed and caulked.
- 4. Pipe insulation complete, pipes labeled and valves tagged.
- 5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 220500



**SECTION 220503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2018 International Building Code
- J. NFPA 5000 - Building Construction Safety Code

**1.4 SUBMITTALS**

- A. Submit under provisions of Section 220500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.
  - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.

3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

## **1.6 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## **1.7 MEETINGS**

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## **1.8 WARRANTY**

- A. Provide one year warranty on parts and labor.

- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Dow Corning Corp.
10. Fire Trak Corp.
11. International Protective Coating Corp.

### **2.2 THROUGH PENETRATION FIRESTOP SYSTEMS**

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material .
- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

### **3.2 INSTALLATION**

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### **3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### **3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 220503

**SECTION 220513 - MOTORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Single Phase and Three Phase Electric Motors.

**1.2 REFERENCES**

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Act of 2007.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 220500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit shop drawings for all three phase motors.
- C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- D. Submit shaft grounding rings or brushes for all motors as required.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

**1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

**1.6 QUALIFICATIONS**

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

**PART 2 - PRODUCTS**

**2.1 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- G. Each contractor shall set all motors furnished by him.
- H. All motors shall have a minimum service factor of 1.15.
- I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- K. Aluminum end housings are not permitted on motors 15 HP or larger.
- L. Motor Driven Equipment:
  - 1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
  - 2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

- M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.
- N. Motors for pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control.

## **2.2 ELECTRICALLY COMMUTATED MOTORS (ECM)**

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
  1. Constant Flow
  2. Constant Temperature
  3. Constant Pressure

## **2.3 MOTORS ON VARIABLE FREQUENCY DRIVES**

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.



- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
  
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 220513

**SECTION 220529 - PLUMBING SUPPORTS AND ANCHORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

**1.2 REFERENCES**

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices
- D. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application.

**1.3 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 220500. Include plastic pipe manufacturers' support spacing requirements.

**1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS**

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

**PART 2 - PRODUCTS****2.1 HANGER RODS**

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"
8" through 12"	7/8"	3/4"
14"	1"	7/8"
16" and 18"	1"	N/A
20" and 24"	1-1/4"	N/A

Column #1: Steel, cast iron, and glass pipe.

Column #2: Copper and plastic pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

## 2.2 PIPE AND STRUCTURAL SUPPORTS

### A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
3. Copper piping located in an exposed area shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

#### a. Products:

- 1) Erico/M-Co Model #456
- 2) B-Line Fig. 3198HCT
- 3) Anvil Fig. CT138R
- 4) Nibco/Tolco Fig. 301CT

### B. Vertical Supports:

1. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

### C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.

3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
5. Unless otherwise indicated, hangers shall be as follows:
  - a. Clevis Type:
    - 1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
    - 2) Products: Bare Steel Plastic or Insulated Pipe:
      - a) Anvil Fig. 260
      - b) Cooper/B-Line Fig. 3100
      - c) Erico Model 400
      - d) Nibco/Tolco Fig. 1
    - 3) Products: Bare Copper Pipe:
      - a) Cooper/B-Line Fig. B3100C
      - b) Nibco/Tolco Fig. 81PVC
  - b. Adjustable Swivel Ring Type:
    - 1) Service: Bare Metal Pipe - 4 inches and Smaller
    - 2) Bare Steel Pipe:
      - a) Anvil Fig. 69
      - b) Cooper/B-Line Fig. B3170NF
      - c) Erico Model FCN
      - d) Nibco/Tolco Fig. 200
    - 3) Bare Copper Pipe:
      - a) Cooper/B-Line Fig. B3170CTC
      - b) Erico 102A0 Series
      - c) Nibco/Tolco Fig. 203
6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
  - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
  - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
  - a. Clamp Type:
    - 1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller

- 2) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
- 3) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
- 4) Bare Steel, Plastic or Insulated Pipe:
  - a) Unistrut Fig. P1100 or P2500
  - b) Cooper/B-Line Fig. B2000 or B2400
  - c) Nibco/Tolco Fig. A-14 or 2STR
- 5) Bare Copper Pipe:
  - a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
  - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
    - 1) Products:
      - a) Anvil Fig. 92
      - b) Cooper/B-Line Fig. B3033/B3034
      - c) Erico Model 300
      - d) Nibco/Tolco 68
  - b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
    - 1) Products:
      - a) Anvil Fig. 228, 292
      - b) Cooper/B-Line Fig. B3054
      - c) Erico Model 360
      - d) Nibco/Tolco Fig. 329
  - c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
    - 1) Products:
      - a) MCL. M1, M2 or M3

## 2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
4. Equipment requiring bases is as follows:
  - a. Expansion Tank
  - b. Water Heater

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

## 2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

- F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150°F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

## 2.5 ROOF PENETRATIONS

- A. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: shall match roofing membrane.
- B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

## 2.6 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
- J. Wall Seals ("Link-Seals"):
  1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
  2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120°F, sleeves may be thermoplastic with integral water seal and textured surface.

3. Sleeves shall be at least 2 pipe sizes larger than the pipes.
4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.
5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	High/Low Temperature (Steam)	Silicone	-67°F to 400°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant/Stainless	Nitrile	-40°F to 210°F

6. Manufacturers:
  - a. Thunderline Corporation "Link-Seals"
  - b. O-Z/Gedney Company
  - c. Calpico, Inc.
  - d. Innerlynx
  - e. Metraflex Company (cold service only)

## 2.7 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.8 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.9 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.10 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.



## PART 3 - EXECUTION

### 3.1 PLUMBING SUPPORTS AND ANCHORS

#### A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

#### B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

#### C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

#### D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.

2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    - a. The hanger is attached within 6" from a web/chord joint.
    - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 7'-0"
      - 2) 1-1/2": 9'-0"
      - 3) 2": 10'-0"
      - 4) 2-1/2": 11'-0"
      - 5) 3": 12'-0"
      - 6) 4" & larger: 12'-0"
  2. Steel (Std. Weight or Heavier - Vapor Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" and under: 9'-0"
      - 2) 1-1/2": 12'-0"
      - 3) 2" & larger: 12'-0"
  3. Hard Drawn Copper & Brass (Liquid Service):
    - a. Maximum Spacing:
      - 1) 3/4" and under: 5'-0"
      - 2) 1": 6'-0"
      - 3) 1-1/4": 7'-0"
      - 4) 1-1/2" 8'-0"

- 5) 2": 8'-0"
- 6) 2-1/2": 9'-0"
- 7) 3": 10'-0"
- 8) 4": 12'-0"
- 9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):

a. Maximum Spacing:

- 1) 3/4" & under: 7'-0"
- 2) 1": 8'-0"
- 3) 1-1/4": 9'-0"
- 4) 1-1/2": 10'-0"
- 5) 2": 11'-0"
- 6) 2-1/2" & larger: 12'-0"

5. Plastic Pipe:

- a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

6. Ultra-Flexible Pipe, and Flexible Hose, and Soft Copper Tubing:

- a. Continuous channel with hangers maximum 8'-0" OC.

- I. Installation of hangers shall conform to MSS SP-58, 69, 89 and the applicable Plumbing Code.

END OF SECTION 220529

**SECTION 220553 - PLUMBING IDENTIFICATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Identification of products installed under Division 22.

**1.2 REFERENCES**

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM B-1, B-3, and B-8 for copper conductors.
- C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 2kV Cables.
- D. CGA Pamphlet C-9, Standard Color-Marking of Compressed Gas Cylinders for Medical Use.
- E. NFPA-99 Health Care Facilities.
- F. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

**1.3 SUBMITTALS**

- A. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

**2.2 MATERIALS**

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

- B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
  1. All valves (except shutoff valves at equipment) shall have numbered tags.
  2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  6. Number all tags and show the service of the pipe.
  7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Equipment:
  1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
  2. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

#### **3.2 SCHEDULE**

- A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:
  1. CONDENSATE DRAIN: White lettering; green background
  2. DOMESTIC COLD WATER: White lettering; green background
  3. DOMESTIC HOT WATER - 115°F: White lettering; green background
  4. DOMESTIC HOT WATER - 140°F: White lettering; green background
  5. DOMESTIC HOT WATER CIRCULATING - 115°F: White lettering; green background
  6. DOMESTIC HOT WATER CIRCULATING - 140°F: White lettering; green background
  7. SANITARY SEWER: Black lettering; yellow background

8. VENT: Black lettering; yellow background
9. NATURAL GAS: Black lettering; yellow background

B. Non-Potable Piping: All piping conveying non-potable water shall be permanently identified by continuously painted along entire length of pipe and branches so the piping is readily distinguishable from piping carrying potable water. Pipe markers shall be located as described above.

1. NON-POTABLE WATER: White lettering; purple background
2. IRRIGATION WATER: White lettering; purple background

END OF SECTION 220553

**SECTION 220719 - PLUMBING PIPING INSULATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Piping Insulation.
- B. Insulation Jackets.

**1.2 QUALITY ASSURANCE**

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

**1.3 REFERENCES**

- A. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- B. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- C. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. NFPA 255 - Surface Burning Characteristics of Building Materials.
- F. UL 723 - Surface Burning Characteristics of Building Materials.
- G. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

**1.4 SUBMITTALS**

- A. Submit shop drawings per Section 220500. Include product description, list of materials and thickness for each service, and locations.

## **PART 2 - PRODUCTS**

### **2.1 INSULATION**

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.
- C. Type F: Phenolic insulation; ASTM C1126; maximum 'K' value of 0.22 at 75°F; density 3.75lb/ft; minimum compressive strength 50 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -290°F to +250°F.

### **2.2 VAPOR BARRIER JACKETS**

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

### **2.3 JACKET COVERINGS**

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
- B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

### **3.2 INSTALLATION**

- A. General Installation Requirements:
  1. Install materials per manufacturer's instructions, building codes and industry standards.
  2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.



- B. Insulated Piping Operating Below 60°F:
1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
  2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
  3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.
- C. Insulated Piping Operating Between 60°F and 140°F:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.
- D. Insulated Piping Operating Above 140°F:
1. Insulate fittings, valves, flanges, and strainers.
  2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
- E. Exposed Piping:
1. Locate and cover seams in least visible locations.
  2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
  3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

### 3.3 SUPPORT PROTECTION

- A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.
- B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    - a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    - b. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    - c. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

- d. Insulation Couplings:
- 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
  - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
    - a) Klo-Shure or equal
  - 3) Vertical:
    - a) Manufacturers: Klo-Shure Titan or equal
- e. Rectangular blocks, plugs, or wood material are not acceptable.
- f. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge

F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 220529 "Plumbing Supports and Anchors".

G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

### 3.4 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
  - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
  - a. Install preformed sections of same material as straight segments of pipe insulation when available.
  - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type F Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive or mastic. Secure butt joint strips in a similar manner.
2. Indoors, above grade or below grade, polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
3. Insulate pipe fittings with prefabricated insulation fittings.

### 3.5 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.

4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.
5. Use plastic insulation covering on all exposed pipes including, but not limited to:
  - a. All exposed piping in areas noted on drawings.
  - b. All exposed piping in locker rooms.
  - c. All exposed piping below 8'-0" above floor.
  - d. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
  - e. All kitchen areas.
6. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.
7. Use colored plastic covering on the following pipes:
  - a. All exterior piping.

### **3.6 SCHEDULE**

- A. Refer to drawings for insulation schedule.

END OF SECTION 220719

**SECTION 221000 - PLUMBING PIPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Check Valves.

**1.2 QUALITY ASSURANCE**

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
- D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

**1.3 REFERENCES**

- A. ANSI/ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above and Below Ground.
- B. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- C. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- E. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- F. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- G. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- H. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
- I. ANSI/ASTM B32 - Solder Metal.
- J. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.
- K. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.

- L. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- N. ANSI/AWWA C153 - Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.
- O. ASME - Boiler and Pressure Vessel Code.
- P. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.
- Q. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- R. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S. ASTM A554 - Standard for Welded Stainless Steel Mechanical Tubing.
- T. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.
- U. ASTM B88 - Seamless Copper Water Tube.
- V. ASTM B306 - Copper Drainage Tube (DWV).
- W. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- X. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- Y. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- Z. ASTM D2661 - ABS DWV Pipe & Fittings.
- AA. ASTM D2665 - PVC DWV Pipe & Fittings.
- BB. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
- CC. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
- DD. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
- EE. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- FF. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- GG. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
- HH. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- II. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

- JJ. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
- KK. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
- LL. AWS A5.8 - Brazed Filler Metal.
- MM. AWWA C651 - Disinfecting Water Mains.
- NN. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- OO. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
- PP. FM 1680 - Couplings Used in Hubless Cast Iron Systems.
- QQ. NFPA 54 - National Fuel Gas Code.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings per Section 220500.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store valves in shipping containers with labeling in place.

#### **1.6 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 220500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### **PART 2 - PRODUCTS**

#### **2.1 CAST IRON PIPE**

- A. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:
  1. Pipe: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
  2. Design Pressure: Gravity Maximum Design Temperature: 180°F
  3. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
  4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 310. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
  5. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

## 2.2 COPPER PIPE

- A. Copper Pipe; Type L; Solder Joints:
  - 1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
  - 2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
  - 3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
  - 4. Fittings: Wrought copper solder joint, ANSI B16.22.
  
- B. Copper Pipe; Type K; Solder Joints:
  - 1. Pipe: Type K annealed copper tube, ASTM B88.
  - 2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
  - 3. Joints: BCuP silver braze, AWS A5.8.
  - 4. Fittings: Wrought copper solder joint, ANSI B16.22.
  
- C. Copper Pipe; Type K; Mechanical Press Connection:
  - 1. Pipe: Type K annealed copper tube, ASTM B88.
  - 2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
  - 3. Joints: Mechanical press connection.
  - 4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.

## 2.3 DUCTILE IRON PIPE

- A. Ductile Iron Pipe; Pressure Water Pipe; Push-On Joints - Pressure Pipe:
  - 1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
  - 2. Design Pressure: 200 psi. Maximum Design Temperature: 150°F.
  - 3. Fittings: Ductile iron, ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, push-on joints.
  - 4. Joint: Push-on joint with rubber gasket, ANSI/AWWA C111/A21.11.
  
- B. Ductile Iron Pipe; Pressure Water Pipe; Mechanical Joints:
  - 1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.
  - 2. Design Pressure: 200 psi. Maximum Design Temperature: 150°F.
  - 3. Fittings: Ductile iron, ANSI/AWWA C110/A21.10, or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, mechanical joints.
  - 4. Joint: Mechanical joint with glands and gaskets and steel bolts. ANSI/AWWAC111/A21.11.

## 2.4 PLASTIC PIPE

- A. Cross-Linked Polyethylene (PEX); Cold Expansion Joint:
  - 1. Tubing: Cross-linked polyethylene (PEX-a or PEX-b), SDR-9, ASTM F876, NSF Certified
  - 2. Design Pressure/Temperature: 100 psig at 180°F.
  - 3. Joints: Bending the tubing greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
  - 4. Fittings: Cold expansion joint compatible with lead-free brass construction. System shall conform to ASTM F1960.



5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.

B. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
3. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 220516 for expansion joint requirements.

## 2.5 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Gate Valves:
  - a. GA-2: 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi CWP @ 150°F, flanged, iron body, bronze mounted, OS&Y. Crane #465-1/2, Hammond, Stockham #G623, Walworth, Milwaukee #F2885, Watts #F-503, Nibco F-617-0.
3. Butterfly Valves:
  - a. BF-1:
    - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Stockham LD712-B&3-E, Nibco LD2000N Series, Milwaukee CL series, Hammond 5200 series.
    - 2) Mechanically coupled grooved end valves are acceptable if they have the features listed above. Victaulic #608, Nibco GD4765.

#### 4. Ball Valves:

- a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
  - 1) Provide solid extended shaft for all insulated piping.
  - 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
- b. BA-9: 2" and under, 150 psi saturated steam, 600 psi CWP, standard port, screwed (solder ends are acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body and ball of copper alloy containing less than 15% zinc, chrome plated or stainless steel ball, Teflon seats and seals with memory stop. Apollo #70-120, Stockham #S-255-FB-P-UL, Milwaukee #BA-100, Watts #B-6000, Hammond #8501, Nibco #580-70.
  - 1) Provide solid extended shaft for all valves in insulated piping.

#### B. Throttling Valves

##### 1. Globe Valves:

- a. GL-1: 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, Nibco T-235Y.
- b. GL-2: 2-1/2" thru 10", 125# steam @ 353°F, 200# CWP @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, Nibco F-718B.

## 2.6 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.
- C. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co. #751, Sarco #CI-125, Watts #77F-D.

## 2.7 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

- B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.
- C. CK-5: 2" and under, 250# CWP, screwed, all iron, horizontal swing. Crane #346-1/2.
- D. CK-6: 2-1/2" thru 12", 125# steam @ 450°F, 200# CWP @ 150°F, flanged, all iron, horizontal swing. Crane #373-1/2, Hammond #IR1126, Stockham #G933, Walworth #8928-1/2F, Milwaukee #F-2971, Watts #F-511-R, Nibco F-918N.

## 2.8 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F and as indicated on the drawings.

## 2.9 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:
  - 1. Iron and steel connected to each other.
  - 2. Brass, copper, and bronze connected to each other.
  - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
  - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
  - 2. Manufacturers:
    - a. Elster Group ClearFlow fittings
    - b. Victaulic Series 647
    - c. Grinnell Series 407
    - d. Matco-Norca

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.

- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- E. Connect to equipment with flanges or unions.
- F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
- G. Roof Penetration (Vent) Flashing:
  - 1. Membrane, Metal or Shingled Roofs: Flash vents with premolded pipe flashing cones for single-ply membrane roofs, metal roofs, or shingled roofs.

### 3.2 SYSTEM, PIPING AND VALVE SCHEDULE

- A. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Above Ground):
  - 1. Copper Pipe; Type L; Solder Joints: All Sizes
  - 2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
  - 3. Copper Pipe; Type L; Mechanically Coupled Grooved Joints: 2-1/2" to 8"
  - 4. Shutoff Valves: BF-1, BA-1
  - 5. Throttling Valves: GL-1, GL-2
  - 6. Check Valves: CK-1, CK-14
  - 7. Strainers: ST-1, ST-7
- B. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Underground):
  - 1. Copper Pipe; Type K; Solder Joints: All Sizes
  - 2. Copper Pipe; Type K; Mechanical Press Connection: 4" and Under
- C. Combination Water and Fire Protection Service:
  - 1. Shutoff Valves: BA-11, BA-12
- D. Sanitary Waste and Vent, Gravity (Above Ground):
  - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- E. Storm Drainage, Gravity (Above Ground):
  - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- F. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
  - 1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
  - 2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
  - 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- G. Storm Drainage, Gravity (Underground - Inside Building):
  - 1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes

2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

H. Sanitary Waste and Vent, Gravity (Underground - Outside Building):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. PVC Pressure Pipe; Schedule 40/SDR26; Push-On Joints - Pressure Pipe: All sizes

I. Storm Drainage, Gravity (Underground - Outside Building):

1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
2. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
3. PVC Pressure Pipe; Schedule 40/SDR26; Push-On Joints - Pressure Pipe: All sizes

J. Condensate/Equipment Drainage:

1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
2. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"

### 3.3 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent, Storm Drainage:

1. Test all piping with water to prove tight.
2. Test piping before insulation is applied.
3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable, Service Water]:

1. Test pipes underground or in chases and walls before piping is concealed.
2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
4. Hold test pressure for at least 2 hours.
5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. Fire Service:

1. Hydrostatically test the entire system for two hours at 200 psig. Maximum leakage shall be:
  - a. Interior Piping: 0 quarts per hour.
  - b. Underground Piping: 2 quarts per 100 joints per hour.

D. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

### 3.4 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

C. Fire Service:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:
  - a. 390 gpm for 4" pipes.
  - b. 880 gpm for 6" pipes.

### 3.5 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal per Section 220529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.
- B. Installation Requirements in Electrical Rooms:
1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- C. Valves/Fittings and Accessories:
1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
  2. Provide clearance for installation of insulation and access to valves and fittings.
  3. Provide access doors for concealed valves and fittings.
  4. Install valve stems upright or horizontal, not inverted.
  5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
  6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
- D. Underground Piping:
1. Install buried water piping outside the building with at least 5 feet of cover. Refer to Section 220500 for Excavation, Fill, Backfill and Compaction requirements
  2. Install buried borosilicate glass pipe with the protective polystyrene covering intact. Lay the pipe on bedding and backfill per manufacturer instructions.
  3. Underground fire protection service piping shall have at least 6-1/2 feet of cover, or as recommended by NFPA 24.
  4. Install thrust blocking and restraints on all underground fire protection service piping per NFPA 24 and as shown on drawings.
  5. Install underground, sleeved, corrugated, stainless steel tubing system according to manufacturer's written instructions. Extend vent from sleeve to exterior of building and terminate with screened elbow.
- E. Sanitary and Storm Piping:
1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
  2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
  3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
  4. Sway Bracing: Where horizontal sanitary and/or storm pipes 4 inches and larger change flow direction greater than 45°, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
  5. All sanitary and storm piping shall have at least 42" of cover when leaving the building.
  6. Starter fittings with internal baffles are not permitted.

### 3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 220500 for Excavation, Fill, Backfill and Compaction requirements.
- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
- N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

### 3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.



- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
- F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- G. All vent and drain piping shall be of same materials and construction for the service involved.

### **3.8 PLUMBING VENTS**

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.
- B. Extend the high side of the soil and waste stacks at least 12" above roof.
- C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
- D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.
- E. In no case shall the vent through the roof be less than 4" in diameter.
- F. Vent pipes through the roof shall be located a minimum of 10 feet from any air intake opening on the roof.

### **3.9 BRANCH CONNECTIONS**

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.
- D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
  - 1. Domestic water piping above ground.
- E. Further limit use of mechanically formed fittings as follows:

1. Must have at least same pressure rating as the main.
2. Main must be Type K or L copper tubing.
3. Permanent marking shall indicate insertion depth and orientation.
4. Branch pipe shall conform to the inner curve of the piping main.
5. Main must be 1" or larger.
6. Branch must be 3/4" or larger.

F. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

G. Forged weld-on fittings are limited as follows:

1. Must have at least same pressure rating as the main.
2. Main must be 2-1/2" or larger.
3. Branch line is at least two pipe sizes under main size.

### 3.10 JOINING OF PIPE

A. Solder Joints (Copper Pipe):

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

B. Brazed Joints (Copper Pipe):

1. Make up joints with silver alloy brazing filler metal conforming to ASTM B260 "Brazing Filler Metal" BAg-1 or BAg-2. Cut copper tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to brazing. Apply non-corrosive flux of the type recommended by filler alloy manufacturer, evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly using oxygen-acetylene torch with tip size recommended by fitting manufacturer. Wipe and brush joint clean after alloy has set.
2. Remove discs from solder end valves during brazing.

C. Mechanically Coupled Grooved Joints (Copper and Galvanized Steel Pipe):

1. Grooved connections shall mechanically engage, lock, and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal. Couplings must be installation-ready style for quick installation and no more than two-piece housings.
2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.
3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts. Torque shall be in accordance with manufacturer's published instructions.
4. All fittings shall be provided by one manufacturer. Mixing grooved components are not acceptable.

5. Product Warranty:
  - a. Standard: One-year product warranty. A factory-trained manufacturer's representative shall visit the site for contractor training and installation observation.
    - 1) On-site Training: Manufacturer's factory trained representative shall provide training of contractor's field personnel in use of grooving tools and installation of product. Documentation of installing contractor training with manufacturer's representative shall be submitted to the Architect/Engineer.
    - 2) Job Site Visitation: Manufacturer's representative shall periodically visit job site to ensure manufacturer's installation practices are being followed.
- D. Mechanical Press Connection (Copper and Stainless Steel Pipe):
  1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
  2. Fully insert tubing into the fitting and mark tubing.
  3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
  4. Joint shall be pressed with a tool approved by the manufacturer.
  5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.
- E. Mechanical Joints (Ductile Iron Pipe):
  1. Joints shall conform to ANSI A21.11 "Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings". Gasket material shall be neoprene. The standard bolts and nuts of the pipe manufacturer shall be used and shall be coated at the factory with rust preventive lubricant after threading and tapping.
  2. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.
- F. Push-On Joints - Pressure Pipe (Ductile Iron, PVC Pressure):
  1. Joints shall be single gasket type conforming to ANSI A21.11 "Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings". The bell shall have cast or machined gasket socket recesses, a tapered annular opening and flared socket design to provide deflections up to 5°. Plain spigot ends shall be suitably beveled for easy entry into bell, centering in gasket and compression of gasket.
  2. The joint shall be liquid tight under all pressures from vacuum to 350 psig.
  3. Furnish sufficient lubricant for a thin coat on each spigot end. Lubricant shall be non-toxic, impart no taste or odor to conveyed liquid, and have no deleterious effect on the rubber gasket. Lubricant shall be of such consistency that it can be easily applied to the pipe in hot and cold weather and shall adhere to either wet or dry pipe.
  4. Assemble per manufacturer's installation instructions.
- G. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):
  1. Gasket shall be heavy weight class, conforming to ASTM C564.
  2. The gasket shall have an internal center stop.
  3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
  4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.

**3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM**

- A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.
- B. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- C. Before starting work, verify system is complete, flushed and clean.
- D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.
- G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.
- H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.
- I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.
- J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

**3.12 SERVICE CONNECTIONS**

- A. Provide new sanitary and/or storm sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service with water meter with bypass valves. Provide sleeve in wall for service main per Section 220529.

END OF SECTION 221000

**SECTION 221023 - NATURAL GAS AND PROPANE PIPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Natural Gas Piping System.

**1.2 QUALITY ASSURANCE**

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

**1.3 REFERENCES**

- A. ANSI AGA-LC1 - Standards for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.
- B. ASME - Boiler and Pressure Vessel Code - Section 9.
- C. ASME B1.20.1 - Pipe Threads, General Purpose.
- D. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- E. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- F. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- G. ASME B16.39 - Malleable Iron Threaded Pipe Unions.
- H. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
- I. ASME B18.2.2 - Square and Hex Nuts, Inch Series.
- J. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- K. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
- L. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.
- M. ASTM A197 - Standard Specification for Cupola Malleable Iron.
- N. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

- O. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- P. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
- Q. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.
- R. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
- S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- T. NFPA 54 - National Fuel Gas Code.

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 22 05 00. Include data on pipe materials, fittings, valves, and accessories.
- B. Test Reports: Provide results of piping system pressure test.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

#### **1.6 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### **PART 2 - PRODUCTS**

#### **2.1 NATURAL GAS (0 to 125 PSI)**

- A. Design Pressure: 125 psi. Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
  - 1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
  - 2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
  - 3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
  - 4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

## C. Piping - 2" and Under:

1. Pipe: Corrugated stainless steel tubing, ASTM A240 Series 300 stainless steel, ANSI AGA-LC1.
2. Jacket: UV resistant, electrically conductive polyethylene, color: black, ASTM E84 25-50 flame and smoke.
3. Fittings: Brass with mechanical ends to fit tubing. ASME B1.20.1 threaded ends for connections to threaded pipes and components.
4. Striker Plates: Minimum 16 gauge hardened steel, corrosion resistant, primed and zinc coated. Install to protect tubing from penetrations.
5. Limits: 5 psi or less.
6. Manufacturers:
  - a. TracPipe (Counterstrike)
  - b. Gastite (Flash Shield)

## D. Piping - 2-1/2" and Over:

1. Pipe: Standard weight steel, beveled ends, ASTM A53.
2. Joints: Butt welded or flanged.
3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

## E. For Underground Gas Piping - Refer to paragraph "Underground Piping Protection."

## F. Shutoff Valves/Throttling Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing.
  - a. Manufacturers:
    - 1) Apollo #80-100
    - 2) Nibco #T580-70-UL or #T585-70-UL
    - 3) Watts #B-6000
3. PL-1: 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port.
  - a. Manufacturers:
    - 1) Walworth #1700
    - 2) DeZurik #425, S-RS49

4. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port.
  - a. Manufacturers:
    - 1) Walworth #1700F
    - 2) DeZurik #425, F-RS49
5. PL-3: 6" and larger, 125# steam @ 450°F, 175# CWP, cast iron body, flanged, resilient faced plug, gear and handwheel operator, full port.
  - a. Manufacturers:
    - 1) Walworth #1707F
    - 2) DeZurik #118, F-RS24

G. Check Valves:

1. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing.
  - a. Manufacturers:
    - 1) Crane #37
    - 2) Hammond #IB904
    - 3) Stockham #B319-Y
    - 4) Walworth #3406
    - 5) Milwaukee #509
    - 6) Watts #B-5000
    - 7) Nibco Y-413B
3. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.
  - a. Manufacturers:
    - 1) Mueller Steam Specialty Co. #71-AHB-6-H
    - 2) Stockham #WG-961 EPDM or #WG970 BUNA
    - 3) NIBCO W-920-W
    - 4) Crane

H. Strainers:

1. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.



2. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F.
  - a. Manufacturers:
    - 1) Armstrong #A1FL
    - 2) Metraflex #TF
    - 3) Mueller Steam Specialty Co.#751
    - 4) Sarco #CI-125
    - 5) Watts #77F-D
  
3. ST-4: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F.
  - a. Manufacturers:
    - 1) Armstrong #A1SC
    - 2) Metraflex #SM
    - 3) Mueller Steam Specialty Co. #11
    - 4) Sarco #IT

## 2.2 NATURAL GAS (126 TO 300 PSI)

- A. Design Pressure: 300 psi.
  1. Maximum Design Temperature: 400°F
  
- B. Piping - 2" and Under:
  1. Pipe: Extra strong seamless black steel, plain ends, ASTM A53, Grade B.
  2. Joints: Socket welded.
  3. Fittings: 3,000# CWP forged steel, socket weld, ASTM A105, Grade II, ANSI B16.11.
  4. Unions: 3,000# CWP forged steel, socket weld ground joint, ASTM A105, Grade II.
  
- C. Piping - 2-1/2" and Over:
  1. Pipe: Extra strong seamless black steel, beveled ends, ASTM A53, Grade B.
  2. Joints: Butt welded or flanged.
  3. Fittings: Extra strong seamless steel, butt weld type, ASTM A234, Grade WPB, ANSI B16.9.
  4. Flanges: 300# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Weld neck type shall have bore to match pipe. Flange face seal weld (backweld) is required for slip-on flanges.
  
- D. For Underground Piping - Refer to paragraph "Underground Piping Protection."
  
- E. Shutoff Valves:
  1. PL-11: 1-1/4" and under, 720# CWP, screwed, cast steel, lubricated type, UL labeled.
    - a. Manufacturer:
      - 1) Walworth #1760

2. PL-12: 1-1/2" and over, 720# CWP, 300# flanged, cast steel, lubricated type, UL labeled.
  - a. Manufacturer:
    - 1) Walworth #1760F

F. Strainers:

1. ST-5: Cast steel body, socket weld ends, screwed cover, 600# steam @ 850°F, 1440# CWP @ 150°F.
  - a. Manufacturers:
    - 1) Armstrong #B1SW
    - 2) Mueller Steam Specialty Co. #862
    - 3) Sarco #CT

## 2.3 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
  1. Gases:
    - a. 1/4" - 2": 1/32" perforations
    - b. 2-1/2" - 10": 3/64" perforations

## 2.4 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

### 3.2 TESTING PIPING

- A. Low Pressure - Up to 1 psi:
  1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.

- B. High Pressure - Above 1 psi:
  1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.
- C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

### 3.3 CLEANING PIPING

- A. Assembly:
  1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
  2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
  3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
  4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

### 3.4 INSTALLATION

- A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
- B. Install piping to conserve building space, and not interfere with other work.
- C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.
- G. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
- H. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
- I. Provide clearance for access to valves and fittings.
- J. Provide access doors where valves are not exposed.
- K. Prepare pipe, fittings, supports, and accessories for finish painting.

- L. Install valves with stems upright or horizontal, not inverted.
- M. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
- N. Provide shutoff valves to isolate part of systems and vertical risers.
- O. Provide shutoff valves to boilers and water heaters in readily accessible location, maximum 6 feet above finished floor, within 6 feet of boiler connection per ASME CSD-1.
- P. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- Q. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
- R. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.
- S. Seal pipes passing through exterior walls with a wall seal per Section 230529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
- T. Refer to Section 230500 for Excavation, Fill, Backfill and Compaction requirements.
- U. Underground Piping Protection:
  - 1. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.
  - 2. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
  - 3. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
  - 4. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
  - 5. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
  - 6. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.
- V. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.
- W. Install underground plastic pipe with an electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape per section 22 05 53 to facilitate locating. One end of the tracer wire or tape shall be brought aboveground at a building wall or riser.

- X. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
- Y. Install underground, sleeved, corrugated, stainless steel tubing system according to manufacturer's written instructions. Extend vent from sleeve to exterior of building and terminate with screened elbow.

### **3.5 BONDING AND GROUNDING**

- A. Each above ground portion of a corrugated stainless steel tubing gas piping systems shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream corrugated stainless steel tube fitting. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent. Gas piping systems that contain one or more segments of corrugated stainless steel tubing shall be bonded in accordance with this section.
- B. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
- C. Gas piping shall not be used as a grounding conductor or electrode.
- D. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

### **3.6 PIPE ERECTION AND LAYING**

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Cut all pipe to exact measurement and install without springing or forcing.

- H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.
- I. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Provide and operate sufficient pumping equipment to maintain excavations, trenches and pits free of water. Dispose of pumped water so operation areas and other facilities are not flooded. Pipe laying shall follow excavating as closely as possible.

### **3.7 DRAINING AND VENTING**

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.
- B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.
- C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

### **3.8 BRANCH CONNECTIONS**

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
  1. Must have at least same pressure rating as the main.
  2. Header or main must be 2-1/2" or over.
  3. Branch line is at least two pipe sizes under header or main size.
- D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

### **3.9 JOINING OF PIPE**

- A. Threaded Joints:
  1. Ream pipe ends and remove all burrs and chips.
  2. Protect plated pipe and valve bodies from wrench marks when making up joints.
  3. Apply gas-rated Teflon tape or thread compound to male threads.
- B. Flanged Joints:
  1. Steel flanges shall be raised face.
  2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
  3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.

4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
  - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
  - b. Maximum pressure rating of at least 250 psig.
  - c. Minimum temperature rating: -10°F.
  - d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

### **3.10 PAINTING EXPOSED PIPE**

- A. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

### **3.11 SERVICE CONNECTIONS**

- A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION 221023

**SECTION 221030 - PLUMBING SPECIALTIES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Cleanouts.
- B. Traps.
- C. Trap Seals and Primers.
- D. Floor Drains and Sinks
- E. Backflow Preventers.
- F. Strainers.
- G. Unions.
- H. Balancing Valves.
- I. Dielectric Fittings (Connections Between Dissimilar Metals).
- J. Air Vents.
- K. Drain Valves.
- L. Relief Valves.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

**1.3 REFERENCES**

- A. ANSI A112.21.1 - Floor Drains.
- B. ASSE 1010 - Water Hammer Arresters.
- C. ANSI A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers.
- D. ANSI A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers.
- E. ASME A112.6.9 - Siphonic Drain Test; The American Society of Mechanical Engineers.
- F. ANSI 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering.



- G. ANSI 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering.
- H. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers; American Society of Sanitary Engineering; 1.
- I. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering.
- J. ASSE 1047 - Reduced Pressure Detector Assemblies.
- K. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
- L. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- M. PDI WH-201 - Water Hammer Arresters.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 220500.
- B. Include sizes, rough-in requirements, service sizes, and finishes.

### **PART 2 - PRODUCTS**

#### **2.1 CLEANOUTS**

- A. Provide cleanouts as shown and specified on the drawings as well as required by code.
- B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
- C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

#### **2.2 YARD CLEANOUTS**

- A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.
- B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

#### **2.3 TRAPS**

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
  1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
  2. Insulated at accessible lavatories.

3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
  4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.
- C. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

#### **2.4 TRAP SEALS AND PRIMERS**

- A. Provide trap seals as specified on the drawings.
- B. Provide trap primers as shown and specified on the drawings.

#### **2.5 FLOOR DRAINS AND SINKS**

- A. Floor drains and sinks shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.
- B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

#### **2.6 BACKFLOW PREVENTERS**

- A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

#### **2.7 STRAINERS**

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
1. Water:
    - a. 1/4" - 2": 3/64" perforations
    - b. 2-1/2" - 10": 1/16" perforations
  2. Lube, Hydraulic, No. 6 Fuel and Waste Oils:
    - a. 1/4" - 2": 3/16" perforations
    - b. 2-1/2" - 10": 3/16" perforations
    - c. 12" - 18": 3/16" perforations
- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.
- C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

#### **2.8 UNIONS**

- A. Copper pipe - wrought copper fitting - ground joint.

- B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.
- C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

## 2.9 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
  1. Carrying case with handle.
  2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
  3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
  4. Coordinate with the Mechanical Contractor if a meter kit is also required in Section 232100. It is not our intent to require two identical kits, rather it will be acceptable to provide only one kit to the owner which can be used with both plumbing and hydronic piping systems.
- D. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi" or Nibco Globe Style balancing valve.
- E. Flow rate less than 0.5 GPM: Valves in copper piping shall be brass or bronze. Cv value shall be less than 1.0 when valve is completely open, and minimum balanceable flow rate shall not exceed 0.1 GPM with a meter reading of at least 2.5 feet. Acceptable manufacturers: Bell & Gossett "Circuit Setter RF", Flow Design, Preso, Armstrong, Griswold, Gerand, or Nibco balancing valve.
- F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

## 2.10 BALANCING VALVE WITH FLOW INDICATION

- A. Balancing valve with built-in visual flow meter, adjustable flow control with memory stop feature, , and tight shutoff.
- B. Maximum working pressure: 150 psi. Maximum Temperature 230°F. Maximum differential pressure: 15 psi. Maximum inlet temperature: 195°F.
- C. Low-lead brass valve, stainless steel springs, EPDM seals.
- D. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on the self-contained visual flow meter.

- E. Acceptable Manufacturers:
  1. Caleffi 132 Series
  2. Watts CSD (provide with separate external temperature gauge)

## 2.11 AUTO-THERMOSTATIC ADJUSTABLE BALANCING VALVE

- A. Adjustable thermostatic balancing valve for domestic hot water recirculation circuits. Dry well with temperature gauge and probe. Internal thermostatic balancing cartridge automatically modulates flow to ensure constant temperature. Adjustable from 95°F to 140°F. Set temperature to 5°F below system temperature.
- B. Sizes: 1/2" and 3/4" with NPT female connections. Flow rating: 2.1 Cv maximum, 0.23 Cv minimum, 0.52 Cv design. Suitable fluid: Water.
- C. Maximum working pressure: 230 psi. Maximum differential pressure: 15 psi. Maximum inlet temperature: 195°F.
- D. Low-lead brass valve, stainless steel and copper adjustable thermostatic cartridge, EPDM hydraulic seals, stainless steel springs, adjustment knob with temperature adjustment scale, and tamperproof adjustment locking screw with probe dry-well port with bypass valve for thermal disinfection function with shutoff valve and check valve with temperature gauge. If manufactured unit does not contain integral gauge, Contractor shall install external gauge immediately upstream of unit.
- E. Acceptable Manufacturers:
  1. Caleffi Thermosetter 116
  2. Acorn TZV-1
  3. B&G Temp Setter

## 2.12 WATER HAMMER ARRESTERS

- A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.
- B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.

## 2.13 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
  1. Iron, steel, and stainless steel connected to each other.
  2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Flanged Joints (any size):
1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
  2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
  3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
  4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
  5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
  6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

#### **2.14 AIR VENTS**

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

#### **2.15 DRAIN VALVES**

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

#### **2.16 RELIEF VALVES**

- A. RV-3: (Compressed Air) Spring loaded disc type, cast iron or steel body, stainless steel disc, side outlet and lifting lever, 250# CWP. Acceptable Manufacturers: Consolidated Div. of Dresser Ind. Series 1900, Kunkle #463, Keckley Type 41.
- B. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

#### **2.17 COMPRESSED AIR FILTERS**

- A. Filters shall have a stainless steel sleeve, micro-glass media with epoxy coating, elastomeric filter to housing seal and sealed end caps.

- B. Filters shall be capable of removing the following:
  1. All solids 3 microns and larger.
  2. Liquids up to 25,000 ppm by weight.
  3. 99% of water droplets.
  4. 40% of oil aerosols.
- C. Provide a differential pressure alarm for each filter. Range shall be adjustable from 10 to 35 psi differential at 100 psig.
- D. Acceptable Manufacturer: Hankison.

## **2.18 COMPRESSED AIR CONDENSATE TRAPS**

- A. Furnish and install traps of the type and capacity shown on the drawings.
- B. Traps shall be mechanically actuated with stainless steel construction, and 10-300 psig working pressure.
- C. Acceptable Manufacturer: Hankison Series 505.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION AND APPLICATION**

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Water Hammer Arresters:
  1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
  2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
  3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.
- D. Cleanouts:
  1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building. Extend cleanouts to the floor with long sweep elbows.
  2. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
  3. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
  4. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

## E. Yard Cleanouts:

1. Install cleanouts on maximum 90 foot centers (including riser) for pipes 8" and smaller.
2. Extend cleanout to grade. Encase cleanout in 5" thick concrete pad extending 6" beyond cleanout, set low enough not to interfere with lawn mowers.

## F. Trap Seals and Primers:

1. Install trap guard on drains not receiving continuous discharge and subject to drying out.
2. Connect trap primer to an active water line 1-1/2" in size or less and which will produce a 3 PSI pressure drop upon fixture operation downstream of the trap primer.

## G. Floor Drains and Floor Sinks:

1. Coordinate sloping requirements with the architectural plans and specifications.
2. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
3. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

## H. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

## I. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION 221030

**SECTION 221123 - DOMESTIC WATER PUMPS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Domestic Water In-Line Circulators.

**1.2 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 220500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Domestic hot water pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 220513.
- G. Submitted pump selections must have a diameter impeller that meets or exceeds the scheduled pump. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

**2.2 DOMESTIC WATER IN-LINE CIRCULATORS**

- A. Provide pumps as specified on the drawings.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. General Installation Requirements:
  - 1. Install all products per manufacturer's recommendations.
  - 2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.



## B. In-Line Pump:

1. Support in-line pumps individually so there is no strain on the piping. Support pump so no weight is carried on pump casings. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
2. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
3. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.

## C. Pump without VFD or ECM:

1. For pumps not powered by a VFD, trim impeller to meet maximum operating conditions. Coordinate final trimmed diameter with Testing, Adjusting, and Balancing Contractor and Engineer.

END OF SECTION 221123

**SECTION 223000 - PLUMBING EQUIPMENT****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Water Heaters.

**1.2 QUALITY ASSURANCE**

- A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:
  - 1. American Gas Association (AGA).
  - 2. National Sanitation Foundation (NSF).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
  - 5. National Electrical Manufacturers' Association (NEMA).
  - 6. Underwriters' Laboratories (UL).
- B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR, ANSI Z21.10.1 and ANSI Z21.10.3.
- C. Conform to ASME Section VIII for construction of water heaters and heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

**1.3 REFERENCES**

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASME Section 8D - Pressure Vessels.
- C. ANSI Section 21.10.1 or Section ANSI 21.10.3 - Gas Water Heaters Ratings 75,000 BTU per Hour and Less.
- D. ANSI/NFPA 30 - Flammable and Combustible Liquids Code.
- E. ANSI/NFPA 54 - National Fuel Gas Code.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.
- H. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.

**1.4 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 220500.
- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

- C. Include heat exchanger dimensions, size ofappings, and performance data.
- D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points,appings, and drains.
- E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.
- F. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.
- G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.
- H. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- I. Submit a current water analysis from the actual water source serving the project site for softening equipment verification before sending shop drawings to the Architect/Engineer.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

### **1.6 REGULATORY REQUIREMENTS**

- A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.
- B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.
- C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

## **PART 2 - PRODUCTS**

### **2.1 WATER HEATERS**

- A. All water heaters shall be as scheduled on the drawings.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install all items in accordance with manufacturer's instructions.

### **3.2 WATER HEATER INSTALLATION**

- A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 220529.
- B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.
- D. Install gas water heaters according to NFPA 54.

END OF SECTION 223000

**SECTION 224000 - PLUMBING FIXTURES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. All plumbing fixtures.

**1.2 REFERENCES**

- A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
- D. ANSI A112.19.2M - Vitreous China Plumbing Fixtures.
- E. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
- G. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
- H. ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
- I. AHRI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- J. ASSE 1002 - Water Closet Flush Tank Ball Cocks.
- K. Americans with Disabilities Act (ADA), Title III.

**1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 220500. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.
- B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. For fixtures and trim requiring electrical connections, submit product data indicating general assembly, components, electrical power/controls wiring diagrams, and service connections.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Wall Hung Fixture Carriers:
  - 1. Material: All Metal, ASME/ANSI A112.6.1M.

2. Manufacturers:
    - a. Zurn
    - b. Smith
    - c. Wade
    - d. Josam
    - e. Watts
    - f. Mifab.
  3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.
- B. All fixtures shall be as scheduled on the drawings.
  - C. All china shall be from the same manufacturer where possible.
  - D. All lavatory and sink trim shall be from the same manufacturer where possible.
  - E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General Installation Requirements:
  1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
  2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
  3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
  4. Install components level and plumb.
  5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
  6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.
  7. Refer to architectural drawings for fixture mounting heights.
  8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
- B. Wall-Mounted Fixture Requirements:
  1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.

C. Floor-Mounted Fixture Requirements:

1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.

D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

E. ADA Accessible Exposed Sink and Lavatory Trim:

1. All exposed sink and lavatory traps, piping and angle stops installed at accessible sink and lavatory locations shall include offset style drain tailpiece, p-trap installed near and parallel with back wall, and insulation kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

F. ADA Accessible Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the General Contractor. Make modifications as necessary to flush valve piping to avoid conflict with grab bars. Common solutions include shortened or offset vacuum breaker tailpieces.

G. Shower Requirements:

1. All acrylic and fiberglass bathtubs and showers shall have a non-shrink grout or manufacturer-approved material installed between the finished floor and floor of the fixture to prevent damage caused by deflection.
2. All rough-in pockets for showers and tubs located in basement floor installations shall be filled in with concrete and sealed tight.

### 3.2 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

### 3.3 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION 224000

## SECTION 230500 - BASIC HVAC REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
  1. Plumbing Work: Refer to Section 220500 "Basic Plumbing Requirements".
  2. Heating Work shall include, but is not necessarily limited to:
    - a. Furnish and install heating hydronic boilers and accessories.
    - b. Furnish and install , condensate return & drainage equipment, and accessories.
    - c. Furnish and install complete heating water system including pumps, piping, insulation, air control equipment, terminal heating equipment, and specialties. Make final connections to all coils, including those furnished by others.
    - d. Furnish and install refrigerant piping, accessories, and final charge of refrigerant.
    - e. Furnish and install condensate drain piping from cooling related equipment such as air handlers and cooling coil drain pans.
    - f. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
    - g. Complete all applicable tests, certifications, forms, and matrices.
  3. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
    - a. Furnish and install built-up air handling units complete with louvers, dampers, filters, coils, fans, motors, housing, curbs, and vibration isolation.
    - b. Furnish and install packaged ground-mounted air handling units complete with dampers, filters, coils, fans, and motors.
    - c. Furnish and install packaged rooftop air handling units complete with curbs.
    - d. Furnish and install air-cooled condensing units and curbs.
    - e. Furnish and install all packaged split systems complete with controls and accessories.
    - f. Furnish and install all specialty data room cooling systems complete with controls and accessories.



- g. Furnish and install hydronic unit heaters including all controls, valving and accessories.
  - h. Furnish and install fin-tube radiation including all controls, valving and accessories.
  - i. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
  - j. Furnish and install complete return air ductwork systems including all fittings, insulation, and inlets.
  - k. Furnish and install all terminal air boxes and reheat coils.
  - l. Furnish and install combustion air ductwork.
  - m. Furnish and install complete fume exhaust systems including fans, ductwork, and fittings.
  - n. Furnish and install complete exhaust ductwork systems including all fittings, insulation, inlets, and fans.
  - o. Furnish and install gas flues, stacks, and breechings.
  - p. Furnish and install all temperature control systems.
  - q. Furnish and install all fire dampers.
  - r. Complete all applicable tests, certifications, forms, and matrices.
4. Temperature Control Work shall include, but is not necessarily limited to:
- a. Furnish and install a complete temperature control system as specified in Section 230900.
  - b. Temperature control system shall consist of a full Direct Digital Control (DDC) system including all accessories, sensors, and programming.
  - c. Furnish automatic control valves and dampers for installation by others.
5. Fire Protection Work: Refer to Section 210500 "Basic Fire Suppression Requirements".
6. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:
- a. Furnish complete testing, adjusting, and balancing as specified in Section 230593, including, but not limited to, air systems, hydronic systems, plumbing systems, and verification of control systems.
  - b. Complete all applicable tests, certifications, forms, and matrices.

### 1.3 OWNER FURNISHED PRODUCTS

- A. The Owner will supply the following items for installation and/or connection by this Contractor:
  - 1. Project Base Bid: Auto-repair garage waste oil heater (transported from separate site). Provide new waste oil storage tank, ductwork, associated controls and accessories.
  - 2. Project Base Bid: Radio equipment room server equipment and server rack assembly, including all associated packaged in-row cooling equipment and heat containment equipment.
- B. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.
- C. This Contractor shall make all mechanical system connections shown on the drawings or as required for fully functional units.
- D. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

#### 1.4 ALTERNATES

- A. Auto repair garage waste oil heater WOH-1, waste oil storage tank, ductwork, associated controls and accessories. Reference drawings for scheduled model and performance data.

#### 1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

- A. Definitions:

1. "Mechanical Contractors" refers to the following:
  - a. Plumbing Contractor.
  - b. Heating Contractor.
  - c. Air Conditioning and Ventilating Contractor.
  - d. Temperature Control Contractor.
  - e. Fire Protection Contractor.
  - f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
  - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
  - a. Light fixtures.
  - b. Gravity flow piping, including condensate.
  - c. Electrical busduct.
  - d. Sheet metal.
  - e. Electrical cable trays, including access space.
  - f. Sprinkler piping and other piping.
  - g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
  - a. Boiler Feed Pumps.
  - b. Burners.
  - c. Hydronic circulation pumps
  - d. Unit Heaters
  - e. Computer Room Air Conditioning Units.
  - f. Condensate Pumps.
  - g. Condensing Units.
  - h. Exhaust Fans
  - i. Gas Trains.
  - j. Packaged Air Handling Units.
  - k. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.

4. Temperature Control Subcontractor's Responsibility:
  - a. Wiring of all devices needed to make the Temperature Control System functional.
  - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
  - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.7 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.
- B. Qualifications:
1. Only products of reputable manufacturers are acceptable.
  2. All Contractors and subcontractors shall employ only workers skilled in their trades.
- C. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the City of Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
  2. Conform to all State Codes.
  3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
  4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
  5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
  6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
  7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- D. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
  2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
  3. Pay all charges for permits or licenses.
  4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
  5. Pay all charges arising out of required inspections by an authorized body.
  6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
  7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- E. Utility Company Requirements:
1. Secure from the appropriate private or public utility company all applicable requirements.
  2. Comply with all utility company requirements.
  3. Make application for and pay for service connections, such as gas.
  4. Make application for and pay for all meters and metering systems required by the utility company.

## F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

## G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

## H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.



## 1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 00	Owner Training Agenda
23 05 03	Fire Seal Systems
23 05 13	Motors
23 05 29	Hangers and Supports
23 05 29	Prefabricated Curbs
23 05 48	Vibration Isolation Equipment
23 05 53	HVAC Identification
23 05 93	Testing, Adjusting, and Balancing
23 07 13	Duct Insulation
23 07 19	HVAC Pipe Insulation
23 09 00	Controls
23 09 13	Instrumentation
23 21 00	Hydronic Piping Systems and Valves
23 21 23	HVAC Pumps
23 25 00	Chemical Treatment Systems
23 31 00	Ductwork
23 31 00	Duct Specialties (such as Turning Vanes)
23 34 23	Power Ventilators
23 34 23	Prefabricated Curbs
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 37 00	Louvers
23 51 00	Prefabricated Stacks
23 52 16	Condensing Boilers

- B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer
- d. Contractor and subcontractors' names and addresses
- e. Supplier and manufacturer's names and addresses
- f. Division of work (e.g., plumbing, heating, ventilating, etc.)

- g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions, or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
  - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 23 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

**1.9 EQUIPMENT SUPPLIERS' INSPECTION**

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  - 1. Air Cooled Condensers
  - 2. Boilers, Burners and Boiler Trim
  - 3. Computer Room Units
  - 4. Condensing Units
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

**1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE**

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

**1.11 NETWORK / INTERNET CONNECTED EQUIPMENT**

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

**1.12 WARRANTY**

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. Provide extended warranty to rooftop air-handling unit compressors and hydronic boilers.

- C. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- D. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

### **1.13 INSURANCE**

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

### **1.14 MATERIAL SUBSTITUTION**

- A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

**PART 2 - PRODUCTS (Not Used)****PART 3 - EXECUTION****3.1 JOBSITE SAFETY**

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

**3.2 EXCAVATION, FILL, BACKFILL, COMPACTION****A. General:**

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

**B. Excavation:**

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

**C. Dewatering:**

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6" sand bedding CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand or to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.

3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe insulation is installed and fully sealed.
    - b. Pipe and duct wall penetrations are sealed.
    - c. Pipe identification and valve tags are installed.
    - d. Main, branch and flexible ducts are installed.
    - e. Diffusers, registers and grilles are installed and connected to ductwork.
    - f. Terminal air box reheat coil piping or wiring is complete.
    - g. Terminal air box control wiring is complete and all control boxes are closed.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01.
- B. Final Jobsite Observation:
1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Inspection by State Boiler Inspector.
  5. Start-up reports on all equipment requiring a factory installation inspection or start-up.



6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div23.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

#### C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Refer to Section 230900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

### **3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES**

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Explanation of all air handling systems.
  3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
  4. Maintenance of equipment.
  5. Start-up procedures for all major equipment.
  6. Explanation of seasonal system changes.
  7. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  1. Water Softener System - 2 hours.
  2. Heating Water System - 2 hours.
  3. Split Systems - 2 hours.
  4. Chemical Treatment System - As defined in Section 232500.
  5. Air Handling System(s) - 4 hours.
  6. Computer Room System(s) - 4 hours.
  7. Exhaust System(s) - 2 hours.
  8. Temperature Controls - As defined in Section 230900.

- G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
- H. Operating Instructions:
1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### **3.7 SYSTEM STARTING AND ADJUSTING**

- A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.
- D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### **3.8 RECORD DOCUMENTS**

- A. The following paragraphs supplement Division 01 requirements.

- B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Refer to Section 230900 for additional requirements for Temperature Control documents.
- E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### **3.9 PAINTING**

- A. This Contractor shall paint the following items:
  - 1. All piping in mechanical room
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- E. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- F. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

**3.10 ADJUST AND CLEAN**

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

**3.11 SPECIAL REQUIREMENTS**

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

**3.12 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION**

- A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.
- B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.
- C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.
- D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.
- E. The following steps shall be taken during testing, adjusting, and balancing of each air system:
  - 1. All construction activities in all spaces served by the air system shall stop.
  - 2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.
  - 3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.

4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.
- F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2. All air handling units operating and balanced.
- 3. All fans shall be operating and balanced.
- 4. All pumps, boilers and chillers operating and balanced.
- 5. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
- 6. All temperature control systems operating, programmed and calibrated.
- 7. Pipe insulation complete, pipes labeled and valves tagged.
- 8. Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 230500

**SECTION 230503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2018 International Building Code

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

**1.5 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.



2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
  - C. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
  - D. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the , General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Products Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Dow Corning Corp.
  10. Fire Trak Corp.
  11. International Protective Coating Corp.

**2.2 THROUGH PENETRATION FIRESTOP SYSTEMS**

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

- a. F Rating = Floor/Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### **3.2 INSTALLATION**

- A. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- B. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

#### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.

- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### **3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### **3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION 230503

**SECTION 230513 - MOTORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Single Phase and Three Phase Electric Motors.

**1.2 REFERENCES**

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Security Act of 2007.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit shop drawings for all three phase motors.
- C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- D. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

**1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

**1.6 QUALIFICATIONS**

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

## PART 2 - PRODUCTS

### 2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Explosion-Proof Motors: UL listed and labeled for the hazard classification shown on the drawing, with over-temperature protection.
- D. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- E. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- F. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- G. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- H. Each contractor shall set all motors furnished by him.
- I. All motors shall have a minimum service factor of 1.15.
- J. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- K. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- L. Aluminum end housings are not permitted on motors 15 HP or larger.
- M. Motor Driven Equipment:
1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.

2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.
- N. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.
- O. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

## **2.2 ELECTRICALLY COMMUTATED MOTORS (ECM)**

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with on-board motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
1. Constant Flow
  2. Constant Temperature
  3. Constant Pressure

## **2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)**

- A. All motors, unless exempted by EPCAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4
50.0	94.1	94.5	93.0	94.1	94.5	93.0
60.0	94.5	95.0	93.6	94.5	95.0	93.6
75.0	94.5	95.0	93.6	94.5	95.4	93.6
100.0	95.0	95.4	93.6	95.0	95.4	94.1
125.0	95.0	95.4	94.1	95.0	95.4	95.0
150.0	95.4	95.8	94.1	95.8	95.8	95.0
200.0	95.4	95.8	95.0	95.8	96.2	95.4
250.0	95.4	95.8	95.0	95.8	96.2	95.8
300.0	95.4	95.8	95.4	95.8	96.2	95.8
350.0	95.4	95.8	95.4	95.8	96.2	95.8
400.0	95.8	95.8	95.8	95.8	96.2	95.8
450.0	96.2	96.2	95.8	95.8	96.2	95.8
500.0	96.2	96.2	95.8	95.8	96.2	95.8

- B. Motor nameplate shall be noted with the above ratings.

## 2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.
- D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.
1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
  2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.



3. In addition to 480 volt motors driven by VFDs, the following critical motors shall also be equipped with shaft grounding rings or brushes or:

#### **2.5 MOTORS FOR WET OR CORROSIVE DUTY**

- A. Where noted for wet and/or corrosive duty, motors shall be designed for severe duty with cast-iron frame, epoxy finish, stainless steel nameplate, polymer shaft seal, corrosion resistant fasteners and fan, moisture resistant windings, and non-wicking leads.

#### **2.6 MOTORS FOR HAZARDOUS DUTY**

- A. Where noted for hazardous duty, motors shall be designed for the class, group, and T code listed for the application. Frame sizes 143T and larger shall have normally closed winding thermostats to keep surface temperatures below the nameplate T code under all conditions.

#### **2.7 SHEAVES**

- A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.
- B. When replacing sheaves, use sheaves of at least the originally supplied sizes.
- C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 230513

**SECTION 230529 - HVAC SUPPORTS AND ANCHORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

**1.2 REFERENCES**

- A. ANSI/ASME B31.1 - Power Piping.
- B. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- C. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
- D. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- E. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application

**1.3 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 230500. Include plastic pipe manufacturers' support spacing requirements.

**1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS**

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

**PART 2 - PRODUCTS****2.1 HANGER RODS**

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"

Column #1: Steel pipe.

Column #2: Copper, plastic and fiberglass reinforced pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

## 2.2 PIPE AND STRUCTURAL SUPPORTS

### A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

### B. Vertical Supports:

1. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

#### a. Products:

- 1) Mason RBA, RCA or RDA
- 2) Mason BR

2. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

### C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Unless otherwise indicated, hangers shall be as follows:
  - a. Clevis Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

- 1) Products: Bare Steel, Plastic or Insulated Pipe:

- a) Anvil Fig. 260

- b) Cooper/B-Line Fig. 3100
    - c) Erico Model 400
    - d) Nibco/Tolco Fig. 1
  - 2) Products: Bare Copper Pipe:
    - a) Cooper/B-Line Fig. B3100C
    - b) Nibco/Tolco Fig. 81PVC
- b. Continuous Channel with Clevis Type: Service: Plastic Tubing, Flexible Hose, Soft Copper Tubing:
  - 1) Products:
    - a) Cooper/B-Line Fig. B3106, with Fig. B3106V
    - b) Erico Model 104, with Model 104V
    - c) Nibco/Tolco Fig. 1V
- c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:
  - 1) Products: Bare Steel Pipe:
    - a) Anvil Fig. 69
    - b) Cooper/B-Line Fig. B3170NF
    - c) Erico Model FCN
    - d) Nibco/Tolco Fig. 200.
  - 2) Products: Bare Copper Pipe:
    - a) Cooper/B-Line Fig. B3170CTC
    - b) Erico 102A0 Series
    - c) Nibco/Tolco Fig. 203
- 5. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
  - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
  - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
- 6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
  - a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
    - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
    - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.

- 3) Products: Bare Steel, Plastic or Insulated Pipe:
  - a) Unistrut Fig. P1100 or P2500
  - b) Cooper/B-Line Fig. B2000 or B2400
  - c) Nibco/Tolco Fig. A-14 or 2STR
- 4) Products: Bare Copper Pipe:
  - a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

- 1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
  - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
    - 1) Products:
      - a) Anvil Fig. 92
      - b) Cooper/B-Line Fig. B3033/B3034
      - c) Erico Model 300
      - d) Nibco/Tolco 68
  - b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):
    - 1) Products:
      - a) Anvil Fig. 228, 292
      - b) Cooper/B-Line Fig. B3054
      - c) Erico Model 360
      - d) Nibco/Tolco Fig. 329
  - c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
    - 1) Products:
      - a) MCL. M1, M2 or M3

## 2.3 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

- 1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
- 2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength).
4. Equipment requiring bases is as follows:
  - a. Air Handling Unit
  - b. Boiler
  - c. Chemical Feed Equipment

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

## 2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

- F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150°F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

## **2.5 ROOF PENETRATIONS**

- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe and duct penetrations. Refer to drawings for details.
- B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: Black shall match roofing material.
- C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

## **2.6 ESCUTCHEON PLATES AND TRIM**

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## **2.7 PIPE PENETRATIONS**

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## **2.8 PIPE ANCHORS**

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## **2.9 FINISH**

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

# **PART 3 - EXECUTION**

## **3.1 HVAC SUPPORTS AND ANCHORS**

- A. General Installation Requirements:
  1. Install all items per manufacturer's instructions.

2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.
  - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.



4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
  - F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
  - G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
  - H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
    1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
      - a. Maximum Spacing:
        - 1) 1-1/4" & under: 7'-0"
        - 2) 1-1/2": 9'-0"
        - 3) 2": 10'-0"
        - 4) 2-1/2": 11'-0"
        - 5) 3": 12'-0"
        - 6) 4" & larger: 12'-0"
    2. Steel (Std. Weight or Heavier - Vapor Service):
      - a. Maximum Spacing:
        - 1) 1-1/4" and under: 9'-0"
        - 2) 1-1/2": 12'-0"
        - 3) 2" & larger: 12'-0"
    3. Hard Drawn Copper & Brass (Liquid Service):
      - a. Maximum Spacing:
        - 1) 3/4" and under: 5'-0"
        - 2) 1": 6'-0"
        - 3) 1-1/4": 7'-0"
        - 4) 1-1/2": 8'-0"
        - 5) 2": 8'-0"
        - 6) 2-1/2": 9'-0"
        - 7) 3": 10'-0"
        - 8) 4": 12'-0"
        - 9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):
  - a. Maximum Spacing:
    - 1) 3/4" & under: 7'-0"
    - 2) 1": 8'-0"
    - 3) 1-1/4": 9'-0"
    - 4) 1-1/2": 10'-0"
    - 5) 2": 11'-0"
    - 6) 2-1/2" & larger: 12'-0"
  
- I. Wood Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
  1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 7'-0"
      - 2) 1-1/2": 9'-0"
      - 3) 2": 10'-0"
      - 4) 2-1/2": 11'-0"
      - 5) 3": 12'-0"
      - 6) 4" through 6": 12'-0" 8": 9'-0" 10": 6'-0" 12": 4'-0"
  
  2. Steel (Std. Weight or Heavier - Vapor Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" and under: 9'-0"
      - 2) 1-1/2": 12'-0"
      - 3) 2" & larger: 12'-0"
      - 4) 2-1/2": 11'-0"
      - 5) 3": 12'-0"
      - 6) 4" through 8": 12'-0"
      - 7) 10": 9'-0"
      - 8) 12": 6'-0"
  
  3. Hard Drawn Copper & Brass (Liquid Service):
    - a. Maximum Spacing:
      - 1) 3/4" and under: 5'-0"
      - 2) 1": 6'-0"
      - 3) 1-1/4": 7'-0"
      - 4) 1-1/2" 8'-0"
      - 5) 2": 8'-0"
      - 6) 2-1/2": 9'-0"
      - 7) 3": 10'-0"
      - 8) 4": 12'-0"
      - 9) 6": 12'-0"

4. Hard Drawn Copper & Brass (Vapor Service):
    - a. Maximum Spacing:
      - 1) 3/4" & under: 7'-0"
      - 2) 1": 8'-0"
      - 3) 1-1/4": 9'-0"
      - 4) 1-1/2": 10'-0"
      - 5) 2": 11'-0"
      - 6) 2-1/2" & larger: 12'-0"
  5. Plastic Pipe:
    - a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.
  6. Ultra-Flexible Pipe, Flexible Hose, and Soft Copper Tubing:
    - a. Continuous channel with hangers maximum 8'-0" OC.
- J. Wood Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 7'-0"
      - 2) 1-1/2": 9'-0"
      - 3) 2": 10'-0"
      - 4) 2-1/2": 11'-0"
      - 5) 3": 12'-0"
      - 6) 4" through 6": 12'-0" 8": 9'-0" 10": 6'-0" 12": 4'-0"
  2. Steel (Std. Weight or Heavier - Vapor Service):
    - a. Maximum Spacing:
      - 1) 1/2" and under: 6'-0"
      - 2) 3/4" to 1": 8'-0"
      - 3) 1-1/4" and under: 9'-0"
      - 4) 1-1/2": 10'-0"
      - 5) 2" & larger: 10'-0"
      - 6) 3": 12'-0"
      - 7) 4" through 8": 12'-0"
      - 8) 10": 9'-0"
      - 9) 12": 6'-0"
  3. Hard Drawn Copper & Brass (Liquid Service):
    - a. Maximum Spacing:
      - 1) 3/4" & under: 5'-0"
      - 2) 1": 6'-0"

- 3) 1-1/4": 6'-0"
- 4) 1-1/2": 6'-0"
- 5) 2": 8'-0"
- 6) 2-1/2": 9'-0"
- 7) 3": 10'-0"
- 8) 4": 10'-0"
- 9) 6": 10'-0"

K. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION 230529

**SECTION 230530 - ROOF SUPPORT AND WIND BRACING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Wind Restraint of Rooftop Equipment
- B. Rooftop Access and Service Platforms
- C. Rooftop Pipe Support
- D. Rooftop Equipment Support

**1.2 QUALITY ASSURANCE**

- A. General:
  - 1. The Contractor shall retain a specialty consultant or equipment manufacturer to develop a wind restraint and support system and perform wind restraint calculations in accordance with these specifications, state, and local codes.
  - 2. These requirements are beyond those listed in Section 230529 of these specifications. Where a conflict arises between the wind restraint of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.
- B. Manufacturer:
  - 1. System Supports/Restraints: Company specializing in the manufacture of products specified in this section.
  - 2. Equipment: Each company providing equipment that must meet wind restraint requirements shall provide certification included in project submittals that the equipment supplied for the project meets or exceeds the wind restraint of the project.
- C. Installer: Installed by Contractor.

**1.3 REFERENCES**

- A. International Building Code 2018
- B. HCAI - Health Care Access and Information (California)
- C. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13
- D. ASCE 7-10, Chapter 29
- E. ASCE 7-16, Chapter 29

**1.4 SUBMITTALS**

- A. Submit under provisions of Section 230500.

B. Shop Drawings:

1. Calculations, restraint selections, and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located and experienced in wind restraint design and installation.
2. Coordination Drawings: Plans and sections drawn to scale, coordinating wind restraint bracing of mechanical components with other systems and equipment in the vicinity, including other wind restraint restraints.
3. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
4. System Supports/Restraints - Submit for each condition requiring wind restraint bracing:
  - a. Calculations for each wind restraint brace and detail used on the project.
  - b. Plan drawings showing locations and types of wind restraint braces on contractor fabrication/installation drawings.
  - c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
  - d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.
5. Equipment - Submit for each piece of equipment supplied:
  - a. Certification that the equipment supplied for the project meets or exceeds the wind restraint requirements specified.
  - b. Specific details of wind restraint design features of equipment and maximum wind restraint loads imparted to the structural support.
  - c. Engineering calculations and details for equipment anchorage and support structure.

- C. A wind restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If wind restraint restraints are not provided for a system that requires wind restraint bracing, the wind restraint designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, used for each item. Wind restraint designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance with the exception.

## 1.5 TESTING AND INSPECTION

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

## 1.7 DESIGN REQUIREMENTS

- A. This project is subject to the wind loading requirements of the International Building Code 2018 edition.

- B. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

## 1.8 COORDINATION

- A. Coordinate layout and installation of anchoring with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

## 1.9 WARRANTY

- A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

## PART 2 - PRODUCTS

### 2.1 DESIGN CRITERIA

- A. The following design criteria applies to all equipment noted below.

- B. General Information:

1. Adopted Building Code:
2. Building Occupancy Risk Category: II

- C. Wind Design Criteria:

1. Mean Roof Height: 18 feet
2. Basic Wind Speed: 100 MPH @ 3-second gust
3. Exposure Category: B

### 2.2 ROOF PIPING SUPPORTS

- A. Non-Penetrating Pillow Block Supports:

1. Provide pre-fabricated non-penetrating pillow block roof pipe supports for all piping installed on the roof.
2. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. Acceptable Products:
  - a. Anvil International HBS-Base Series
  - b. Cooper B-Line Dura-Blok
  - c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load)
  - d. Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe)

### 2.3 ROOF EQUIPMENT SUPPORTS

- A. Premanufactured Equipment Roof Support Frames:

1. Provide adjustable prefabricated roof equipment supports for all equipment installed on the roof. Supports include stanchioned supports anchored to the roof structure.

2. Frame: Support frame shall be hot dipped galvanized steel minimum 12 gauge channel or tube steel. Manufacturer shall determine final design.
  3. Equipment requiring support frames is as follows:
    - a. Condensing units
    - b. Split system outdoor units
  4. Minimum clear height above roof shall be 24 inches.
- B. Equipment Roof Curbs and Rails:
1. Equipment requiring curbs or rails with this section is as follows:
    - a. Condensing units
    - b. Rooftop Units
    - c. Exhaust Fans
  2. Provide prefabricated curbs or rails as follows:
    - a. Roof Mounting Curb: Minimum 18 inches (mm), minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
    - b. 18 gauge counter flashing completely covering nailer.
    - c. Factory insulated with rigid fiberglass.
  3. Refer to drawings for curb and rail heights.
  4. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.
  5. Manufacturers:
    - a. Thy
    - b. Pate
    - c. United
    - d. Roof Products Systems
    - e. Portals Plus
- C. Rooftop Air Handling Units:
1. Standard Curb: Rooftop equipment such as packaged air handling units shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
- D. Exhaust Fans:
1. Curb provided with equipment. Rooftop equipment such as roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
  2. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Install all items per manufacturer's instructions.



- B. All wind restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- C. Installation of wind restraints shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
- D. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
- E. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast-in-place inserts.
- F. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only. Do not install cables over sharp corners.
- G. Provide reinforced clevis bolts when required.
- H. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
- I. Piping crossing building seismic or expansion joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as required to provide required motion capability and limit motion of adjacent piping.
- J. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Supports shall extend directly to building structure.
- M. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the drawings as being by others.
- N. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
- O. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.

### **3.2 ROOF PIPING SUPPORTS**

- A. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.
- B. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
- C. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

- D. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories, to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
- E. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
- F. Support piping at equipment and valves so it can be disconnected and removed without further supporting the piping.
- G. Piping shall not introduce strains or distortion to connected equipment.
- H. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, and at equipment connections and heavy fittings.
- I. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.
- J. Spacing: Refer to Supports and Anchors section for pipe spacing requirements.

### **3.3 INSPECTION**

- A. Special inspection and testing shall be done in accordance with Chapter 17 of the International Building Code.
- B. The Owner shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.
- C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.
- D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, the Engineer of Record, and the General Contractor. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

END OF SECTION 230530

**SECTION 230548 - HVAC VIBRATION ISOLATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Vibration Isolation.
- B. Flexible Connectors.

**1.2 SUBMITTALS**

- A. Submit shop drawings per Section 230500 and the Vibration Isolation Submittal Form at the end of this section.
- B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
- C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.
- D. Isolator submittals shall include:
  - 1. Equipment served
  - 2. Type of Isolator
  - 3. Load in Pounds per Isolator
  - 4. Recommended Maximum Load for Isolator
  - 5. Spring Constants of Isolators (for Spring Isolators)
  - 6. Load vs. Deflection Curves (for Neoprene Isolators)
  - 7. Specified Deflection
  - 8. Deflection to Solid (at least 150% of calculated deflection)
  - 9. Loaded (Operating) Deflection
  - 10. Free Height
  - 11. Loaded Height
  - 12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
  - 13. Materials and Coatings
  - 14. Spring Diameters
- E. Make separate calculations for each isolator on equipment where the load is not equally distributed.
- F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

**PART 2 - PRODUCTS****2.1 BASIC CONSTRUCTION AND REQUIREMENT**

- A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

- B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.
- C. The lateral to vertical stiffness ratio ( $K_x/K_y$ ) of spring isolators shall be between 0.8 and 2.0.
- D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.
- E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.
- F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.
- G. Provide motor slide rails for belt-driven equipment per Section 230513.
- H. All isolators, except M1, shall have provision for leveling.

## 2.2 MOUNTINGS

- A. Type M2:
  1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
    - a. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
  2. All units shall have bolt holes and be bolted down.
  3. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
  4. Manufacturers:
    - a. Mason Industries "ND" or "DNR"
    - b. Amber/Booth "RVD"
    - c. Kinetics "RD"
    - d. Vibration Mountings and Controls "RD"
    - e. Vibration Eliminator Co. "T22" or "T44"

## 2.3 HANGERS

- A. Type H1:
  1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
  2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
  3. Provide hangers with end connections as required for hanging ductwork or piping.

4. Manufacturers:
  - a. Mason "HD"
  - b. Kinetics "RH"
  - c. Aeroflex "RHD"
  - d. Vibration Eliminator Co. "IC/3C/3CTD"
  - e. Vibro Acoustics "RH"

## 2.4 BASES

- A. Type B2:
  1. Steel members welded to height-saving brackets to cradle machines having legs or bases that do not require complete supplementary bases.
  2. Members shall be sufficiently rigid to prevent strains in the equipment.
  3. Manufacturers:
    - a. Mason "ICS"
    - b. Kinetics "SFB"
    - c. Aeroflex

## 2.5 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

- A. Type FC1:
  1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
  2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.
  3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
  4. Connectors up to 2" size may have threaded ends.
  5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
  6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
  7. Manufacturer:
    - a. Metraflex "Double Cable-Sphere"
    - b. Minnesota Flex Corp.
    - c. Mercer "200 Series"
    - d. Twin City Hose "MS2".
- B. Type FC2:
  1. Stainless steel flexible connectors with corrugated stainless steel hose body and stainless steel braided casing.
  2. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
  3. Sizes 2" and under shall have steel threaded connections.
  4. Sizes 2-1/2" and over shall have 150 lb. steel flanges.
  5. Suitable for 1/2" permanent misalignment.
  6. Manufacturers:
    - a. Mason or Mercer "BSS-GU"
    - b. Metraflex "ML"
    - c. Twin City Hose "TCHS"
    - d. American "BOA B4-1"

- e. Flexible Metal Hose Company "FM-21"
- f. or Wheatley.

## 2.6 VIBRATION ISOLATION CURBS

### A. Spring Isolated Curbs:

1. Provide factory fabricated vibration isolated curb consisting of an upper floating section resting on a rigid rectangular steel tube structure containing adjustable steel vibration isolation springs.
2. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
3. Vibration Isolation:
  - a. Isolators shall consist of free standing, unhoused laterally stable steel springs.
  - b. Springs shall be zinc electroplated.
  - c. Springs shall rest on a minimum of 1/4" neoprene pad.
  - d. Springs shall provide a minimum of 1-1/2" deflection calculated based on final assembled loads.
4. Provide continuous wood nailing strip and counter flashing along entire perimeter of the curb.
5. Provide continuous air and water seal, such as an EPDM bellows, around the entire curb.
6. Curb assembly shall withstand 125#/sf lateral wind loading against the supported equipment.
7. The curb shall be designed with lateral restraint to meet seismic requirements specified in Section 230550.
8. Coordinate internal structural cross framing with ductwork and piping routed in the curb.
9. Manufacturers:
  - a. Mason Industries, Inc. - Type RSC
  - b. Vibration Elimination Company - BERG
  - c. ThyCurb - Vibro Curb II
  - d. Kinetics - SSR.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Provide vibration isolation as indicated on the drawings and as described herein.
- C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.
- D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.
- E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

- F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

### 3.2 PIPE ISOLATION

- A. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.
- B. Provide sufficient piping flexibility for vibrating refrigerant equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.
- C. Support piping to prevent extension of flexible connectors.

### 3.3 VIBRATION ISOLATION SCHEDULE

- A. Inline Pumps:
  - 1. Base Type: NA
  - 2. Isolator Type: M3 or H2 or H3
  - 3. Static Deflection :0.75"
  - 4. Flexible Connections: NA
- B. Packaged HVAC Unit (less than 10 HP):
  - 1. Base Type: NA
  - 2. Isolator Type: M3 or H2 or H3
  - 3. Static Deflection: 0.75"
  - 4. Flexible Connections: Per Section 233300
- C. Packaged HVAC Unit (greater than 15 HP, less than 4" static pressure):
  - 1. Base Type: NA
  - 2. Isolator Type: M3 or H2 or H3
  - 3. Static Deflection: Refer to ASHRAE Table
  - 4. Flexible Connections: Per Section 233300
- D. Condensing Unit (Roof Mounted):
  - 1. Base Type: NA
  - 2. Isolator Type: M4
  - 3. Static Deflection: 0.75"
  - 4. Flexible Connections: NA

END OF SECTION 230548

**SECTION 230553 - HVAC IDENTIFICATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Identification of products installed under Division 23.

**1.2 REFERENCES**

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM B-1, B-3, and B-8 for copper conductors.
- C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 - 2kV Cables.
- D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500. Include list of items identified, wording, letter sizes, and color coding.
- B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.



## 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

Plastic tags may be used for outside diameters under 3/4"

- B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- D. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.
- E. Ductwork Markers:
1. Ductwork systems containing hazardous materials shall be provided with minimum 2" x 4" ANSI Z535.2 biohazard warning labels with custom labeling describing hazard. Refer to Part 3 for system and label description.
  2. Vinyl Markers: Colored vinyl with permanent pressure sensitive adhesive backing suitable for indoor and outdoor application.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
1. All valves (except shutoff valves at equipment) shall have numbered tags.
  2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  6. Number all tags and show the service of the pipe.
  7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.

8. Provide one 36" x 24" minimum Plexiglas framed piping schematic showing valve locations with respective tag numbers. Mount directory in location chosen by the Architect/Engineer.
9. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
  - a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
  - b. Apply primer on non-insulated pipes before painting.
  - c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
  - a. At each valve.
  - b. On both sides of walls that pipes penetrate.
  - c. At least every 20 feet along all pipes.
  - d. On each riser and each leg of each "T" joint.
  - e. At least once in every room and each story traversed.
5. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Ductwork Markers:

1. Apply ductwork markers on ductwork systems containing hazardous materials in the following locations where clearly visible:
  - a. On both sides of walls that ducts penetrate.
  - b. At least every 20 feet along all ducts.
  - c. On each riser and each leg of each branch connection.
  - d. At least once in every room and each story traversed.
  - e. At all ductwork access doors.
  - f. At all fans and equipment serving ductwork system. Markers shall be clearly visible from the normal maintenance access path to the equipment. Coordinate placement location with Owner.

F. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

G. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

### 3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. HEATING WATER SUPPLY: White lettering; green background
2. HEATING WATER RETURN: White lettering; green background
3. PUMPED CONDENSATE: Black lettering; yellow background
4. CONDENSATE DRAIN: White lettering; green background
5. COMPRESSED AIR: White lettering; green background
6. CONTROL COMPRESSED AIR: White lettering; green background
7. NATURAL GAS: Black lettering; yellow background
8. REFRIGERANT LIQUID: White lettering; purple background
9. REFRIGERANT SUCTION: White lettering; purple background

END OF SECTION 230553

**SECTION 230593 - TESTING, ADJUSTING, AND BALANCING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of cooling systems.
- D. Testing, adjusting, and balancing of plumbing systems.
- E. Measurement of final operating condition of HVAC systems.

**1.2 QUALITY ASSURANCE**

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

**1.3 REFERENCES**

- A. AABC - National Standards for Total System Balance, Seventh Edition.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing (latest edition).
- H. TABB - International Standards for Environmental Systems Balance.

**1.4 SUBMITTALS**

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

- B. Electronic Copies:
1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
  2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
  3. All text shall be searchable.
  4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

## **1.5 REPORT FORMS**

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

## **1.6 WARRANTY/GUARANTEE**

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

## **1.7 SCHEDULING**

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

**PART 2 - PRODUCTS (Not Used)****PART 3 - EXECUTION****3.1 GENERAL REQUIREMENTS**

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 230900 for additional information.
- H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

**3.2 EXAMINATION**

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
  - 1. General Equipment Requirements:
    - a. Equipment is safe to operate and in normal condition.
    - b. Equipment with moving parts is properly lubricated.
    - c. Temperature control systems are complete and operable.
    - d. Proper thermal overload protection is in place for electrical equipment.
    - e. Direction of rotation of all fans and pumps is correct.
    - f. Access doors are closed and end caps are in place.
  - 2. Duct System Requirements:
    - a. All filters are clean and in place. If required, install temporary media.
    - b. Duct systems are clean and free of debris.
    - c. Fire/smoke and manual volume dampers are in place, functional and open.

- d. Air outlets are installed and connected.
- e. Duct system leakage has been minimized.

3. Pipe System Requirements:

- a. Coil fins have been cleaned and combed.
- b. Hydronic systems have been cleaned, filled, and vented.
- c. Strainer screens are clean and in place.
- d. Shutoff, throttling and balancing valves are open.

- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

### 3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

### 3.4 INSTALLATION TOLERANCES

- A.  $\pm 10\%$  of scheduled values:
  - 1. Adjust air inlets and outlets to  $\pm 10\%$  of scheduled values.
  - 2. Adjust piping systems to  $\pm 10\%$  of design values.
- B. Adjust supply, return, and exhaust air-handling systems to  $+10\%$  /  $-5\%$  of scheduled values.

### 3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.
- E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

### 3.6 SYSTEM PERFORMANCE REPORT

- A. After the conclusion of balancing operations, utilize the building DDC system or install portable data loggers to simultaneously record temperatures and humidity during summer and winter conditions for a seven-day period, continuous over a weekend, and including at least one period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition and within 10°F dry bulb temperature of minimum winter design condition.
- B. Design Conditions:
  - 1. Summer:        99°F DB        78°F WB
  - 2. Winter:        0°F DB
- C. Architect/Engineer will direct all test locations.
- D. Report of test results shall include original recording and three reproductions.

### 3.7 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

## PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

### 4.1 GENERAL REQUIREMENTS

- A. Title Page:
  - 1. Project name.
  - 2. Project location.
  - 3. Project Architect.
  - 4. Project Engineer (IMEG Corp.).
  - 5. Project General Contractor.
  - 6. TAB Company name, address, phone number.
  - 7. TAB Supervisor's name and certification number.
  - 8. TAB Supervisor's signature and date.
  - 9. Report date.
- B. Report Index
- C. General Information:
  - 1. Test conditions.
  - 2. Nomenclature used throughout report.
  - 3. Notable system characteristics/discrepancies from design.
  - 4. Test standards followed.
  - 5. Any deficiencies noted.
  - 6. Quality assurance statement.
- D. Instrument List:
  - 1. Instrument.
  - 2. Manufacturer, model, and serial number.
  - 3. Range.
  - 4. Calibration date.



## 4.2 AIR SYSTEMS

- A. Duct Leakage Test:
  - 1. Air system and fan.
  - 2. Leakage class.
  - 3. Test pressure.
  - 4. Construction pressure.
  - 5. Flow rate (cfm): specified and actual.
  - 6. Leakage (refer to Section 233100 in the specifications): specified and actual.
  - 7. Statement that fire dampers, reheat coils and other accessories were included in the test.
  - 8. Pass or Fail.
  - 9. Test performed by.
  - 10. Test witnessed by.
  
- B. Air Moving Equipment:
  - 1. General Requirements:
    - a. Drawing symbol.
    - b. Location.
    - c. Manufacturer, model, arrangement, class, discharge.
    - d. Fan RPM.
    - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
    - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
  - 2. Flow Rate:
    - a. Supply flow rate (cfm): specified and actual.
    - b. Return flow rate (cfm): specified and actual.
    - c. Outside flow rate (cfm): specified and actual.
    - d. Exhaust flow rate (cfm): specified and actual.
  - 3. Pressure Drop and Pressure:
    - a. Filter pressure drop: specified and actual.
    - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
    - c. Inlet pressure.
    - d. Discharge pressure.
  
- C. Fan Data:
  - 1. Drawing symbol.
  - 2. Location.
  - 3. Manufacturer and model.
  - 4. Flow rate (cfm): specified and actual.
  - 5. Total static pressure: specified and actual. (Indicate measurement locations).
  - 6. Inlet pressure.
  - 7. Discharge pressure.
  - 8. Fan RPM.

## D. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

## E. Duct Traverse:

1. System zone/branch/location.
2. Duct size.
3. Free area.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Duct static pressure.
7. Air temperature.
8. Air correction factor.

## F. Air Terminal (Inlet or Outlet):

1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

## G. Air Terminal Unit (Terminal Air Box) Data:

## 1. General Requirements:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer and model.
- d. Size.
- e. Type: constant, variable, single, dual duct.

## 2. Flow Rate:

- a. Cooling maximum flow rate (cfm): specified and actual.
- b. Heating maximum flow rate (cfm): specified and actual.
- c. Minimum flow rate (cfm): specified and actual.
- d. Water flow rate (gpm): specified and actual with system performance adjusted as follows:
  - 1) Adjust heating water system pump to maintain maximum system differential pressure.
  - 2) Set calibrated balance valve fully open.
  - 3) Command terminal air box control valve to fully open.
  - 4) Measure heating coil flow using calibrated balance valve.
  - 5) Note: Commanding terminal air box control valve to be fully open shall be done on a valve-by-valve basis. Do not command all control valves to be fully open at the same time, as the heating water system may not have sufficient capacity.

- 6) Note: After Balancing of all terminal air boxes is complete, release the heating water pump to automatically reset the system DP based on control valve position per sequence of operation requirements.

3. Temperature:
  - a. Entering air temperature: specified and actual.
  - b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.
  - c. Entering water temperature: specified and actual.
  - d. Leaving water temperature: specified and actual.
4. Pressure Drop and Pressure:
  - a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).
  - b. Water pressure drop: specified and actual.

#### H. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

#### I. Positive Air Flow Test:

1. Occupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
2. Occupied Return Air (Max./Min.) Flow rate (cfm): specified and actual.
3. Unoccupied Supply Air (Max./Min.) Flow rate (cfm): specified and actual.
4. Unoccupied Return Air (Min./Max.) Flow rate (cfm): specified and actual.

### 4.3 HEATING SYSTEMS

#### A. Pump Data (Primary and Secondary Heating Water Loop Pumps):

1. Existing drawing symbol or equipment TAG
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: Operating and shutoff.
8. Discharge Pressure: Operating and shutoff.
9. Final frequency of motor at maximum flow rate (on pumps driven by VFD).

#### B. Electric Motors (Associated Heating Water Loop Pump Motors):

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

## C. Heating Coils:

1. General Requirements:
  - a. Drawing symbol.
  - b. Service.
  - c. Location.
  - d. Manufacturer and model.
  - e. Size.
2. Flow Rate:
  - a. Flow rate (cfm): specified and actual.
  - b. Water flow rate: specified and actual.
3. Temperature:
  - a. Entering air temperature: specified and actual.
  - b. Leaving air temperature: specified and actual.
  - c. Entering water temperature: specified and actual.
  - d. Leaving water temperature: specified and actual.
4. Pressure Drop and Pressure:
  - a. Air pressure drop: specified and actual.
  - b. Steam pressure after valve: specified and actual.
  - c. Water pressure drop: specified and actual.
5. Energy:
  - a. Air Btuh (cfm x temp rise x 1.09).
  - b. Water Btuh (gpm x temp drop x 500). Repeat tests if not within 10% of air Btuh.

## D. Terminal Heat Transfer Units:

1. General Requirement:
  - a. Drawing symbol.
  - b. Location.
  - c. Manufacturer and model.
  - d. Include air data only for forced air units.
2. Flow Rate:
  - a. Flow rate (cfm): specified and actual.
  - b. Water flow rate (cfm): specified and actual.
3. Temperature:
  - a. Entering air temperature: specified and actual.
  - b. Leaving air temperature: specified and actual.
  - c. Entering water temperature: specified and actual.
  - d. Leaving water temperature: specified and actual.

4. Energy:
  - a. Air Btuh (cfm x temperature rise x 1.09).
  - b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

E. Hot Water Boiler:

1. General Requirements:
  - a. Drawing symbol.
  - b. Service.
  - c. Location.
  - d. Manufacturer, model, and identification number.
  - e. Control setting: specified and actual.
2. Flow Rate:
  - a. Flow rate (gpm): specified and actual.
3. Pressure Drop:
  - a. Pressure Drop: specified and actual.
4. Temperature:
  - a. Entering water temperature: specified and actual.
  - b. Leaving water temperature: specified and actual.
5. Energy:
  - a. Rating (Btuh).
  - b. Measured output (Btuh).

#### 4.4 COOLING SYSTEMS

A. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

B. Cooling Coils:

1. General Requirements:
  - a. Drawing symbol.
  - b. Service.
  - c. Location.
  - d. Size.
  - e. Manufacturer and model.

2. Temperature:
    - a. Entering air DB temperature: specified and actual.
    - b. Entering air WB temperature: specified and actual.
    - c. Leaving air DB temperature: specified and actual.
    - d. Leaving air WB temperature: specified and actual.
  3. Pressure Drop and Pressure:
    - a. Air pressure drop: specified and actual.
  4. Energy:
    - a. Air Btuh (cfm x enthalpy change x 4.5).
- C. Terminal Heat Transfer Units:
1. General Requirements:
    - a. Drawing symbol.
    - b. Location.
    - c. Manufacturer and model.
    - d. Include air data only for forced air units.
  2. Temperature:
    - a. Entering air DB temperature: specified and actual.
    - b. Leaving air DB temperature: specified and actual.
    - c. Entering water temperature: specified and actual.
    - d. Leaving water temperature: specified and actual.
  3. Flow rate:
    - a. Flow rate (cfm): specified and actual.
    - b. Water flow (gpm): specified and actual.
  4. Energy:
    - a. Air Btuh (cfm x temperature rise x 1.09).
    - b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

#### 4.5 PLUMBING SYSTEMS

- A. Pump Data:
1. Drawing symbol.
  2. Service.
  3. Manufacturer, size, and model.
  4. Impeller size: specified, actual, and final (if trimmed).
  5. Flow Rate (gpm): specified and actual.
  6. Pump Head: specified, operating and shutoff.
  7. Suction Pressure: operating and shutoff.
  8. Discharge Pressure: operating and shutoff.

## B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

## C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

## D. Gas Fired Water Heater:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Capacity (Btuh): specified, nameplate, and actual.
6. Entering water temperature: specified and actual.
7. Leaving water temperature: specified and actual.
8. Pressure Drop: specified and actual.
9. Control Setting: specified and actual.

END OF SECTION 230593

**SECTION 230713 - DUCTWORK INSULATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Ductwork Insulation.
- B. Insulation Jackets.

**1.2 QUALITY ASSURANCE**

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials:
  - 1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
  - 2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
  - 3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

**1.3 REFERENCES**

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E136 - Standard Test Method for the Behavior of Materials in a Vertical Tube Furnace at 750°C.
- F. ASTM E814 - Fire Tests of Through Penetrations Firestops.
- G. ASTM E2336-04 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
- H. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- I. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.



- J. NFPA 96 - Standard for the Installation of Equipment for Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- K. NFPA 255 - Surface Burning Characteristics of Building Materials.
- L. UL - XHEZ - Through Penetration Firestop Systems.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- N. UL 263 - Full Scale External Fire Tests with Hose Stream.
- O. UL 723 - Surface Burning Characteristics of Building Materials.
- P. UL 1479 - Fire Tests of Through Penetrations Firestops.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and location.
- B. Submit manufacturer's installation instructions.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.
- B. Type E: Double wall ductwork insulation; fiberglass; 0.27 maximum 'K' value at 75°F mean temperature; 1.5 lb/cu ft density.
- C. Type I: Flexible Elastomeric Liner; EPDM (NBR/PVC Blend is not permitted) Elastomeric cellular foam sheet; ANSI/ASTM C534; 0.25 maximum 'K' value at 75°F; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; coated air side for 5000 fpm air velocity.

TYPE	THICKNESS K-FACTOR	R-VALUE PER THICKNESS							
		0.5	1	1.5	2	2.5	3	4	5
Flexible Fiberglass Outside Wrap	0.28			5.4	7.1	8.9	10.7	14.3	17.9
Semi-Rigid Fiberglass Board Wrap	0.25			6.0	8.0	10.0	12.0	16.0	20.0
Flexible Fiberglass Liner	0.28	1.8	3.6	5.4	7.1	8.9	10.7	14.3	17.9
Rigid fiberglass liner	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7
Double Wall Ductwork	0.27		3.7	5.6	7.4	9.3	11.1	14.8	18.5
Flexible High Temp Rigid Preformed Fiberglass Acoustical Liner	0.23		4.3	6.5	8.7	10.9	13.0	17.4	21.7

## 2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

## 2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM B209; 0.016" thick; smooth or embossed stucco finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
- B. Stainless Steel Jackets: Type 304 stainless steel; 0.010" thick; smooth finish with Z edge seams and stainless steel bands for outdoor use.
- C. Laminated flexible aluminum, self-adhering, protective jacketing, vapor barrier and weather proofing membrane with having high-performance adhesive capable of installation with no additional mechanical attachment. White finish.
1. Acceptable Manufacturers:
    - a. VentureClad 1577CW
    - b. Polyguard Alumaguard

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

E. Exterior Duct Wrap - Flexible, Type A:

1. Apply with edges tightly butted.
2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
3. Seal joints with adhesive backed tape.
4. Apply so insulation conforms uniformly and firmly to duct.
5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Interior Insulation - Flexible Duct Liner, Type C:

1. Observation of Duct Lining:
  - a. After installation of ductwork, Architect/Engineer may select random observation points in each system.
    - 1) At each observation point, cut and remove an 18" x 18" section of ductwork and liner for verification of installation.
    - 2) Random observation points based on one opening per 75 lineal ft. of total duct run.
  - b. When any of the observation points shows non-compliance, additional points will be designated by the Architect/Engineer, and observation repeated.
  - c. If 20% of points observed do not comply, remove and replace all lined ducts and repeat tests. Where replacement is not required, correct all non-compliances.
  - d. At end of observation, repair all duct lining and observation holes by installing standard, insulated, hinged access doors per Section 233300.
  - e. Paint or finish to match adjacent duct surfaces.
2. Impale on spindle anchors welded or mechanically fastened to the duct. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins less than 3" from corners and at intervals not over 6" around the perimeter at leading and trailing edges. Locate pins within 3" of transverse joints and at intervals not over 16" long the length of the duct. Pins must be long enough to prevent compressing the insulation.
3. In addition to anchors, secure liner with UL listed adhesive covering over 90% of the duct surface.
4. Install per the latest edition of the SMACNA Manual.

5. Leading edges shall be covered as follows:
  - a. For duct velocities below 3000 fpm, coat leading edges with adhesive. Neatly butt liner without gaps at transverse joints. Cut liner flush with end of the duct section for tight joints with no exposed duct. If adhesive is shop installed, field apply additional adhesive to the end of each duct section for complete adhesion of the liner. Protect edges from dirt and debris.
  - b. For duct velocities above 3000 fpm, cover leading edges with metal nosing. Use nosing on upstream edges of each section of duct. If the duct can be installed in either direction, provide nosing on each end or clearly mark the duct to allow visual verification after installation. Verify duct velocities based on the scheduled air flow rates and determine where metal nosing is required.
  - c. Install metal nosing in the following locations (regardless of velocity):
    - 1) The first three fittings downstream of all fans.
    - 2) At all duct liner interruptions. This includes fire dampers, access doors, branch connections, and all other locations where the edge of the liner is exposed.
    - 3) Trailing edges of transverse joints do not require metal nosings.
6. Overlap liner at longitudinal joints. Make longitudinal joints at corners of the duct unless the duct size does not allow this. Coat longitudinal joints with adhesive at velocities over 2500 fpm.
7. Seal all damaged duct liner with adhesive and glass cloth. Do not damage duct liner surface coatings.
8. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

G. Double-Wall Ductwork Insulation - Type E:

1. Install insulation per manufacturer's recommendations.
2. Duct dimensions given are net inside dimensions of inner wall.

H. Preformed Fiberglass Acoustical Liner, Rigid - Type G:

1. Cut and secure duct liner inside duct.
2. Install insulation pins or adhesives in locations as recommended by the manufacturer.
3. Seal all damaged duct liner and fill all gaps with manufacturer approved sealant. Do not damage duct liner surface coatings.
4. Where edges show evidence of delamination, the damaged areas shall be secured by manufacturer approved sealant.
5. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

### 3.2 SCHEDULE

- A. Refer to Section 233100 for scheduling of insulation.

END OF SECTION 230713

**SECTION 230719 - HVAC PIPING INSULATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Piping Insulation.
- B. Insulation Jackets.

**1.2 QUALITY ASSURANCE**

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

**1.3 REFERENCES**

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- C. ANSI/ASTM C534 - Elastomeric Foam Insulation.
- D. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation.
- E. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- F. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- G. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation.
- H. ASTM C578 - Preformed Cellular Polystyrene Thermal Insulation.
- I. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- J. ASTM C1729 - Standard Specification for Aluminum Jacketing for Insulation.

- K. ASTM E84 - Surface Burning Characteristics of Building Materials.
- L. NFPA 255 - Surface Burning Characteristics of Building Materials.
- M. UL 723 - Surface Burning Characteristics of Building Materials.
- N. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

#### 1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500. Include product description, list of materials and thickness for each service, and locations.

### PART 2 - PRODUCTS

#### 2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.
- C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.
- D. Type F: Phenolic insulation; ASTM C1126; maximum 'K' value of 0.22 at 75°F; density 3.75lb/ft; minimum compressive strength 50 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -290°F to +250°F.

#### 2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.
- B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

## 2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.
- B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.
- B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

### 3.2 INSTALLATION

- A. General Installation Requirements:
  - 1. Install materials per manufacturer's instructions, building codes and industry standards.
  - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
  - 3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
  - 4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.
- B. Insulated Piping Operating Below 60°F:
  - 1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
  - 2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
  - 3. All balance valves and strainers with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.
- C. Insulated Piping Operating Between 60°F and 140°F:
  - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.
2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).

E. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and not required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

### 3.3 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
  - a. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
  - b. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
  - c. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
    - 1) Products:
      - a) Buckaroo CoolDry



- b) Cooper/B-Line Fig. B3380 through B3384
  - c) Pipe Shields A1000, A2000
  - d. Insulation Couplings:
    - 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
    - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
      - a) Klo-Shure or equal
    - 3) Vertical Manufacturers:
      - a) Manufacturers: Klo-Shure Titan or equal
  - e. Rectangular blocks, plugs, or wood material are not acceptable.
  - f. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.
- C. Neatly finish insulation at supports, protrusions, and interruptions.
- D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
- E. Shields shall be at least the following lengths and gauges:
- | Pipe Size      | Shield Size         |
|----------------|---------------------|
| 1/2" to 3-1/2" | 12" long x 18 gauge |
| 4"             | 12" long x 16 gauge |
| 5" to 6"       | 18" long x 16 gauge |
- F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 230529 "HVAC Supports and Anchors".
- G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

### 3.4 INSULATION

- A. Type A Insulation:
1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
  2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
  3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
  - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
  - a. Install preformed sections of same material as straight segments of pipe insulation when available.
  - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.

D. Type F Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive or mastic. Secure butt joint strips in a similar manner.
2. Indoors, above grade or below grade, polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
3. Insulate pipe fittings with prefabricated insulation fittings.

### 3.5 JACKET COVER INSTALLATION

#### A. Metal Covering:

1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.

#### B. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.
5. Use plastic insulation covering on all exposed pipes including, but not limited to:
  - a. All exposed piping in finished spaces.
  - b. All exposed piping in areas noted on drawings.
  - c. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
6. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

### 3.6 SCHEDULE

- #### A. Refer to drawings for insulation schedule.

END OF SECTION 230719

**SECTION 230900 - CONTROLS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

**1.3 REFERENCES**

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/ASHRAE Standard 135-2001: BACnet® - A Data Communication Protocol for Building Automation and Control Networks, including all amendments.
- D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).
- E. ANSI/NFPA 70 - National Electrical Code.
- F. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- G. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- H. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

**1.4 SUBMITTALS**

- A. Equipment Coordination:
  - 1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
  - 2. Control valve selections shall be based on flow rates shown in approved shop drawings.

3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 230500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
  - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
  - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  - c. Identification of all control components connected to emergency power.
  - d. Schematic diagrams for all field sensors and controllers.
  - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
  - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
  - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
  - h. All installation details and any other details required to demonstrate that the system will function properly.
  - i. All interface requirements with other systems.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
  - a. Damper Identification Tag.
  - b. Location.
  - c. Damper Type.
  - d. Damper Size.
  - e. Duct Size.
  - f. Arrangement.
  - g. Blade Type.
  - h. Velocity.
  - i. Pressure Drop.
  - j. Fail Position.
  - k. Actuator Identification Tag.
  - l. Actuator Type.
  - m. Mounting.
10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
  - a. Valve Identification Tag.
  - b. Location.
  - c. Valve Type.
  - d. Valve Size.
  - e. Pipe Size.
  - f. Configuration.
  - g. Flow Characteristics.
  - h. Capacity.
  - i. Valve  $C_v$ .
  - j. Design Pressure Drop.
  - k. Pressure Drop at Design Flow.
  - l. Fail Position.
  - m. Close-off Pressure.
  - n. Valve and Actuator Model Number and Type.
11. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.
12. Provide PICS files indicating the BACnet functionality and configuration of each device.

13. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.
14. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
15. Software: A list of operating system software, operator interface software, color graphic software, and third-party software.
16. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
17. Clearly identify work by others in the submittal.
18. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 230500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
  - a. Table of contents with indexed tabs dividing information as outlined below.
  - b. Definitions: List of all abbreviations and technical terms with definitions.
  - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
  - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
  - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
  - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
  - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
  - h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
  - i. Original Software: Complete original issue CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
  - j. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
  - k. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

## D. Training Manual:

1. Provide a course outline and training manuals for each training class.

## E. Record Documents:

1. Submit record documentation per Section 230500.
2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

**1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION**

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.
- D. Gauge Taps.
- E. Flow Meters.

**1.7 AGENCY AND CODE APPROVALS**

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
  1. UL-916; Energy Management Systems.
  2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
  3. EMC Directive 89/336/EEC (European CE Mark).
  4. FCC, Part 15, Subpart J, Class A Computing Devices.



## 1.8 ACRONYMS

- A. Acronyms used in this specification are as follows:
1. B-AAC BACnet Advanced Application Controller
  2. B-ASC BACnet Application Specific Controller
  3. BTL BACnet Testing Laboratories
  4. DDC Direct Digital Controls
  5. FMCS Facility Management and Control System
  6. GUI Graphic User Interface
  7. IBC Interoperable BACnet Controller
  8. IDC Interoperable Digital Controller
  9. LAN Local Area Network
  10. NAC Network Area Controller
  11. ODBC Open DataBase Connectivity
  12. OOT Object Oriented Technology
  13. OPC Open Connectivity via Open Standards
  14. PICS Product Interoperability Compliance Statement
  15. PMI Power Measurement Interface
  16. POT Portable Operator's Terminal
  17. TCC Temperature Control Contractor
  18. TCS Temperature Control System
  19. WAN Wide Area Network
  20. WBI Web Browser Interface

## 1.9 SUMMARY

- A. Provide new standalone FMCS for this project.
- B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.
- D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

## 1.10 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.
- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.
- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.

- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.
- G. For each operator workstation provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

#### **1.11 SOFTWARE LICENSE AGREEMENT**

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.

#### **1.12 JOB CONDITIONS**

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

#### **1.13 WARRANTY**

- A. Refer to Section 230500 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

#### **1.14 WARRANTY ACCESS**

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. BACnet Protocol:
  - 1. Johnson Controls: Metasys Extended Architecture

### **2.2 SYSTEM ARCHITECTURE**

- A. General:
  - 1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
  - 2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

### **2.3 NETWORKS**

- A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.
- B. Local area network minimum physical and media access requirements:
  - 1. Ethernet; IEEE Standard 802.3.
  - 2. Cable; 100 Base-T, UTP-8 wire, Category 6.
  - 3. Minimum throughput; 100 Mbps.
- C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.
- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

### **2.4 REMOTE NETWORK ACCESS**

- A. For Local Area Network installations, provide access to the LAN from a remote location via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

## 2.5 NETWORK AREA CONTROLLER (NAC)

- A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.
- B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:
1. Calendar functions.
  2. Scheduling.
  3. Trending.
  4. Alarm monitoring and routing.
  5. Time synchronization.
  6. Integration of all controller data.
  7. Network Management functions.
- C. The Network Area Controller shall provide the following hardware features as a minimum:
1. One Ethernet Port - 10/100 Mbps.
  2. One RS-232 port.
  3. One RS-485 port.
  4. Battery backup.
  5. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
  6. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
  7. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
  8. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.
- D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.
- F. Event Alarm Notification and Actions:
1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
  3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    - a. Alarm
    - b. Normal
  4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.
  5. Provide timed (scheduled) routing of alarms by class, object, group, or node.

6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Treat control equipment and network failures as alarms and annunciated.
- H. Annunciate alarms in any of the following manners as defined by the user:
1. Screen message text.
  2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
    - a. Day of week.
    - b. Time of day.
    - c. Recipient.
  3. Pagers via paging services that initiate a page on receipt of e-mail message.
  4. Graphic with flashing alarm object(s).
  5. Printed message, routed directly to a dedicated alarm printer.
- I. The FMCS shall record the following for each alarm:
1. Time and date.
  2. Location (building, floor, zone, office number, etc.).
  3. Equipment tag.
  4. Acknowledge time, date, and user who issued acknowledgement.
  5. Number of occurrences since last acknowledgement.
- J. Give defined users proper access to acknowledge any alarm.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

## 2.6 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).

C. Interoperable BACnet Controller (IBC):

1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
  - a. BACnet Building Controller(s) (B-BC).
  - b. BACnet Advanced Application Controller(s) (B-ACC).
  - c. BACnet Application Specific Controller(s) (B-ASC).
3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
  - a. BACnet Device; MAC address, name, type and instance number.
  - b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
  - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.

- b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
  - c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
  - d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
  - e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
- a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
  - b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
  - c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
  - d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
  - e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.

- f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
  - g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
  - h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.
  - i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
  - j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.
  - k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:
- a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.
  - b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.
  - c. For BACnet devices, provide the following objects:
    - 1) Analog In.
    - 2) Analog Out.
    - 3) Analog Value.
    - 4) Binary.



- 5) Binary In.
- 6) Binary Out.
- 7) Binary Value.
- 8) Multi-State In.
- 9) Multi-State Out.
- 10) Multi-State Value.
- 11) Schedule Export.
- 12) Calendar Export.
- 13) Trend Export.
- 14) Device.

- d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
- e. For BACnet devices, provide the following support at a minimum:

- 1) Segmentation.
- 2) Segmented Request.
- 3) Segmented Response.
- 4) Application Services.
- 5) Read Property.
- 6) Read Property Multiple.
- 7) Write Property.
- 8) Write Property Multiple.
- 9) Confirmed Event Notification.
- 10) Unconfirmed Event Notification.
- 11) Acknowledge Alarm.
- 12) Get Alarm Summary.
- 13) Who-has.
- 14) I-have.
- 15) Who-is.
- 16) I-am.
- 17) Subscribe COV.
- 18) Confirmed COV notification.
- 19) Unconfirmed COV notification.
- 20) Media Types.
- 21) Ethernet.
- 22) BACnet IP Annex J.
- 23) MSTP.
- 24) BACnet Broadcast Management Device (BBMD) function.
- 25) Routing.

## 2.7 TERMINAL AIR BOX (TAB) CONTROLLERS

- A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 233600 for additional information.
- B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.
- C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

- D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.
- E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

## 2.8 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:
  1. Designating the log as interval or deviation.
  2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
  3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
  4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
  5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.
- C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- D. All log data shall be available to the user in ALL the following data formats:
  1. HTML.
  2. XML.
  3. Plain text.
  4. Comma or tab separated values.
- E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:
  1. Archive on time of day.
  2. Archive on user-defined number of data stores in the log (buffer size).
  3. Archive when log has reached its user-defined capacity of data stores.
  4. Provide ability to clear logs once archived.

## 2.9 AUDIT LOG

- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
  1. Time and date.
  2. User ID.
  3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

## 2.10 DATABASE BACKUP AND STORAGE

- A. The NAC shall automatically backup its database on a user-defined time interval.
- B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.
- C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

## 2.11 GRAPHIC USER INTERFACE SOFTWARE

- A. Operating System:
  - 1. Provide computer with the most current Microsoft-based operating system with which the GUI has proven compatibility.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu pulldowns and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line) that displays the location and the selected object identification.
- C. Point Organization: Organize points by equipment categories, location, or other means acceptable to Owner.
- D. Real-Time Displays: The GUI shall support the following graphic features and functions:
  - 1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file. Use of proprietary graphic file formats is not acceptable. In addition to, or in lieu of, a graphic background, the GUI shall support the use of scanned pictures.
  - 2. Graphic screens shall be able to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
  - 3. Graphics shall support layering, and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
  - 4. Modifying common application objects, such as schedules, calendars, and setpoints, shall be accomplished graphically.
    - a. Schedule times shall be adjusted using a graphic slider without requiring any keyboard entry from the operator.
    - b. Holidays shall be set by using a graphic calendar without requiring any keyboard entry from the operator.
  - 5. Commands to start and stop binary objects shall be made by selecting the object and the appropriate command from a pop-up menu. No text entry shall be required.
  - 6. Adjustments to analog objects, such as setpoints, shall be made by selecting the object and using a graphic slider to adjust the value. No text entry shall be required.

- E. System Configuration: At a minimum, the GUI shall include the necessary software and components to enable the operator to perform the following tasks with proper password access:
  1. Create, delete or modify control strategies.
  2. Add/delete objects.
  3. Tune control loops by adjusting control loop parameters.
  4. Enable or disable control strategies.
  5. Generate hard copy records or control strategies on a printer.
  6. Select alarm points and define the alarm state.
  7. Select points to be trended and initiate the recording of values automatically.
  8. View any trend as a graph.
  
- F. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available using hypertext. All system documentation and help files shall be in HTML format.
  
- G. Security: Each operator shall be required to log on to that system with a user name and password to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall be able to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall be automatically logged off the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. Store all system security data in an encrypted format.
  
- H. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. Annunciate the failure of any device to the operator.
  
- I. Alarm Console:
  1. The system shall have a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and to acknowledge the alarm.
  2. When the alarm console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator are not acceptable. The use of the alarm console can be enabled or disabled by the system administrator.

## 2.12 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™, or Chrome. Systems requiring additional software to enable a standard Web browser to reside on the client machine, or manufacturer-specific browsers, are not acceptable.
  
- B. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphic User Interface. Systems that require different views or that require different means of interacting with objects, such as schedules or logs, are not permitted.

- C. The Web browser client shall provide:
1. User log-on identification and password shall be required. If an unauthorized user attempts access, display a blank web page. Implement security using Java authentication and encryption techniques to prevent unauthorized access.
  2. Graphic screens developed for the GUI shall be the same screens used for the Web browser client. The web browser interface shall support all animated graphic objects supported by the GUI.
  3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
  4. Store all graphic screens in the Network Area Controller (NAC) without requiring any graphics storage on the client machine.
  5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
  6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    - a. Modify common application objects, such as schedules, calendars, and setpoints, graphically.
      - 1) Schedule times shall be adjustable using a graphic slider, without requiring any keyboard entry from the operator.
      - 2) Holidays shall be set using a graphic calendar, without requiring any keyboard entry from the operator.
    - b. Commands to start and stop binary objects shall be made by right-clicking the selected object and selecting the appropriate command from a pop-up menu. No text entry shall be required.
    - c. View logs and charts.
    - d. View and acknowledge alarms.
    - e. Setup and execute SQL queries on log and archive information.
  7. The system shall be able to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just his/her defined home page. From the home page, links to other views or pages in the system shall be possible, if allowed by the system administrator.
  8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on intranet sites by specifying the Uniform Resource Locator (URL) for the desired link.

## 2.13 SERVER FUNCTIONS AND HARDWARE

- A. Provide a central server located at mechanical room. The server shall support all NACs connected to the customer's network whether local or remote.
- B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1, or dial-up connection.
- C. It shall be possible to provide access to all NACs via a single connection to the server. In this configuration, each NAC can be accessed from a remote GUI or from a standard WBI by connecting to the server.

D. The server shall provide the following functions:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
3. The server shall include a master clock service for its subsystems and provide time synchronization for all NACs.
4. The server shall accept time synchronization messages from trusted precision atomic clock Internet sites and update its master clock based on this data.
5. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
6. The server shall provide demand limiting that operates across all NACs. The server must be capable of running multiple demand programs for sites with multiple meters and/or multiple sources of energy. Each demand program shall be able to support separate demand shed lists.
7. Each NAC supported by the server shall be able to automatically archive its log data, alarm data and database to the server. Archiving options shall be user-defined, including archive time and archive frequency.
8. The server shall provide central alarm management for all NACs supported by the server. Alarm management shall include:
  - a. Routing alarms to display, printer, e-mail, and pagers.
  - b. Viewing and acknowledging alarms.
  - c. Querying alarm logs based on user-defined parameters.
9. The server shall provide central management of log data for all NACs supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
  - a. Viewing and printing log data.
  - b. Exporting log data to other software applications.
  - c. Querying log data based on user-defined parameters.
10. Reports shall be generated automatically or manually, and directed to LCD displays, printers, or disk files. The system shall allow the user to easily obtain the following types of reports:
  - a. List all points in network.
  - b. List all points in alarm.
  - c. List all off-line points.
  - d. List all points in override status.
  - e. List all disabled points.
  - f. List all points that are locked out.
  - g. List all items defined in a "follow-up" file.
  - h. List all weekly and holiday schedules.
  - i. List all limits and deadbands.

E. Server Hardware Requirements:

1. Provide a High-Mid Range CPU as defined by [www.cpubenchmark.net](http://www.cpubenchmark.net) (minimum processing speed of 2.9 GHz with 8.0 GB RAM and a 1-terabyte minimum hard drive). It shall include one parallel port, one asynchronous serial port and four USB ports. Include a 21" minimum flat panel color monitor, 8ms response time.
2. The server operating system shall be the latest version of Microsoft Windows and Microsoft internet browser.

3. Connect to the FMCS network via an Ethernet network interface card, 1 Gbps.
4. Provide a color laser printer with a minimum 600 x 600-dpi resolution and 12 ppm print speed.
5. For dedicated alarm printing, provide a continuous feed printer using roll or fan-fed microperforated paper. The printer shall have a parallel port interface.

#### **2.14 GRAPHIC USER INTERFACE COMPUTER HARDWARE (DESKTOP)**

- A. Provide a browser workstation with a High-Mid Range CPU as defined by [www.cpubenchmark.net](http://www.cpubenchmark.net) with 8.0 GB RAM and a 1 terabyte minimum hard drive. It shall include one parallel port, one asynchronous serial port and six USB ports. Include a 21" minimum flat panel color monitor, 8ms response time.
- B. The workstation operating system shall be the latest version of Microsoft Windows and Microsoft internet browser.
- C. Connect to the FMCS network via a 1 Gbps Ethernet network interface card.
- D. Provide a color laser printer with minimum 600 x 600-dpi resolution and 12 PPM print speed.

#### **2.15 UNINTERRUPTIBLE POWER SUPPLY (UPS)**

- A. A UPS shall be provided for each of the following:
  1. FMCS workstations and servers.
  2. Network area controllers.
  3. Chiller plant manager.
  4. Boiler plant manager.
- B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for 5 minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.
- C. Manufacturers:
  1. Sola/Hevi-Duty
  2. Eaton Powerware
  3. APC

#### **2.16 SYSTEM PROGRAMMING**

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.

- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods:
1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
  2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
  3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
  4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
  5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

## 2.17 DDE DEVICE INTEGRATION

- A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
1. DDE Generic AI Object.
  2. DDE Generic AO Object.
  3. DDE Generic BO Object.
  4. DDE Generic BI Object.

## 2.18 MODBUS SYSTEM INTEGRATION

- A. The NAC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.



- B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:
  1. Read/Write Modbus AI Registers.
  2. Read/Write Modbus AO Registers.
  3. Read/Write Modbus BI Registers.
  4. Read/Write Modbus BO Registers.
- C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.
- D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

## 2.19 SOFTWARE

- A. IDC/IBCs shall operate totally standalone and independent of a central computer for all specified control applications.
- B. Software shall include a complete operating system (OS), communications handler, point processing, energy management application packages as specified herein, standard control algorithms and specific control sequences (IDC/IBC) and an Owner/user custom control calculation package complete with interpreter.
- C. OS software shall be PROM resident, operate in real time, provide prioritized task scheduling, control time programs, monitor and manage communications, and scan inputs and outputs.
- D. Each IDC/IBC panel shall include the following energy management routines:
  1. Time of day scheduling.
  2. Optimum start/stop.
  3. Peak demand limiting.
  4. Economizer control.
  5. PID control.
  6. Supply air reset.
  7. Outdoor air reset.
- E. Input/output point processing software shall include:
  1. Update of all connected input and output points at least once per second.
  2. Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32-bit floating point format. Retain both the maximum and minimum values sensed for each analog input in memory. It shall be possible to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full-scale 32-bit conversion to achieve high accuracy readout.
  3. A reasonability check on all analog inputs against previous values and discarding of values falling outside preprogrammed reasonability limits.
  4. Assignment of proper engineering units and status conditions to all inputs and outputs.

5. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and alarm) to an input or to assign a set of floating limits (alarm a reset schedule or FMCS control point) to the input. Assign each alarm a unique differential to prevent a point from oscillating in and out of alarm. Make alarm comparisons of each scan cycle.
  6. Adjustment of timing from two seconds to two minutes in one-second increments to eliminate nuisance alarms on startup.
- F. Command Control software shall manage the receipt of commands from the server and from control programs.
1. Provide command delay to prevent simultaneous energizing of loads. Delay must be programmable from 0 to 30 seconds.
  2. Assign each command a command and residual priority to manage conflicts created by multiple programs having access to the same command point. Allow only outputs with a higher command priority to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
  3. A "fixed mode" option (override) shall allow inputs to and outputs from control programs to set to a fixed state or value. When in the "fixed mode", assign inputs and outputs high residual command priority to prevent override by application programs.
- G. Alarm lockout software shall prevent nuisance alarms. On initial start-up of mechanical equipment, assign a "timed lockout" period to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period shall be programmable for each point from 0 to 90 minutes in one-minute increments.
- H. A "hard lockout" shall also be provided to positively lock out alarms when equipment is turned off or when a true alarm depends on the condition of an associated point. Hard lockout points and lockout initiators shall be operator programmable.
- I. Runtime shall be accumulated based on the status of a digital input point. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Runtime counts shall reside in non-volatile memory and have DCP resident runtime limits assignable through the operator's terminal.
- J. A transition counter shall count the number of times a device is cycled on or off. Counter shall be non-volatile and capable of counting 600,000 cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
- K. Custom IDC/IBC programs shall meet the control strategies called for in the sequence of operation of these specifications. Each IDC/IBC shall have resident in its memory and available to the programs a full library of IDC/IBC algorithms, intrinsic control operators, arithmetic, logic, and relational operators. Provide the following features:
1. Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self-learning). Use Adaptive Control where the controlled flow rate is variable (such as TAB units and variable flow pumping loops). The adaptive control algorithm shall monitor the loop response to output corrections and adjust the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of the system dynamics so that, on system shutdown and restart, the learning process starts from where it left off. Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.

2. All IDC/IBC setpoints, gains and time constants associated with IDC/IBC programs shall be available to the operator for display and modification via the operator workstation.
  3. The execution interval of each IDC/IBC loop shall be adjustable from 2 to 120 seconds in one-second increments.
  4. IDC/IBC control programs shall assign initialization values to all outputs so controlled devices assume a failsafe position on start-up.
- L. Provide time and event programming (TEP) capability to initiate a controlled sequence of events for execution at a specific time or upon the occurrence of an event. Minimum program features required are:
1. Analog points commandable to a specific value.
  2. Digital points commandable to a specific state; e.g. on or off; fast, slow or off.
  3. Initiator to be a specific day and time or a specific event; e.g. an alarm.
  4. Manual initiation via operator's command.
  5. Commands must honor command delays (to prevent current surges), and assigned minimum ON and OFF times.
  6. Commands must honor command and residual priority structures allowing higher priority commands (like smoke control) to override lower priority commands (like time of day scheduling) and residual priority.
  7. Ability to chain TEPs.
  8. Ability to enable and disable TEPs individually.
  9. Ability to enable/disable TEP initiators.
- M. Store Energy Management application programs and associated data files in non-volatile or 72-hour battery backed RAM memory. Individual programs shall be accessible from the operator workstation for enabling/disabling and program parameter modification and shall include:
1. Time Programs:
    - a. Provide an independent start and stop program time for each system identified in the points list.
    - b. It shall be possible to assign two independent start and stop times/days to any equipment connected to a controller.
  2. Exception Day Scheduling:
    - a. Provide an Exception Day program for holiday and other planned exceptions to time programs. Exception schedules shall be DSC resident and operator programmable up to one year in advance.
    - b. The program shall allow definition of up to 32 exception time spans. Define each span by calendar start day and calendar stop day.
  3. An IDC/IBC resident temporary scheduler shall allow operators to modify present time program control of equipment. Minimum feature set required is:
    - a. Ability to alter time schedules as much as six days in advance.
    - b. Ability to alter either start time, stop time or both for each day.
    - c. Temporary schedule shall be in effect for all days specified.
    - d. Automatically delete the temporary schedule and restore program to normal schedule after execution.
    - e. Ability to assign schedule changes as permanent as well as temporary.

- N. The IDC/IBC shall have built-in, non-descriptive, self-test procedure for checking the indication lights, digital display, and memory. It shall display advisories for maintenance, performance, and/or software problems.
- O. All electronics shall be:
  - 1. Standard locally stocked modular boards.
  - 2. Plug-in type.
  - 3. Furnish all ROM programs unlocked.

## 2.20 HYDRONIC CONTROL VALVES

- A. General:
  - 1. Two-position valves shall be a minimum of line size with a maximum allowable pressure drop of 1 psi.
  - 2. Size two-way and three-way modulating valves to provide a pressure drop at full flow of 4 to 5 psi, except boiler three-way and cooling tower bypass valves shall not have a pressure drop over 4 psi.
  - 3. Modulating two-way valves shall have equal percentage flow characteristics.
  - 4. Modulating three-way valves shall have linear flow characteristics.
  - 5. Piping geometry correction factors for  $C_v$  ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.
- B. Two-position:
  - 1. Ball 2" and under:
    - a. Design Pressure: 400 psi
      - 1) Design Temperature: 212°F
      - 2) Design Flow Differential Pressure Rating: 150 psi
    - b. Bronze or brass body, stainless steel stem, chrome plated brass or stainless steel full port ball, EPDM, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470°F melting point of 95-5 solder).
  - 2. Butterfly 2-1/2" to 12":
    - a. Design Pressure: 125 psi
      - 1) Design Temperature: -20 to 212°F
      - 2) Design Flow Differential Pressure Rating: 50 psi
    - b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.
- C. Modulating:
  - 1. Pressure Independent Control Valves (PIC Valves or PICV) 3/4" and Smaller:
    - a. Design Pressure: 360 psi
    - b. Close-off Pressure: 75 psig
    - c. Design Temperature: Between 36°F to 212°F

- d. Pressure independent operation up to system delta-p of 50 psid minimum; maximum pressure drop of 5.0 psid at design flow; 0% leakage; forged brass body; NPT female ends; stainless steel ball and stem, PTFE seats and dual EPDM seals.
- e. Acceptable Manufacturers:
  - 1) Flow Control Industries
  - 2) Belimo
  - 3) Tour Anderson
  - 4) Bray
  - 5) Danfoss

2. Pressure Independent Control Valves (PIC Valves or PICV) NPS 6 (DN 150) and Smaller:

- a. Design Pressure for NPS 2 (DN 50) and Smaller: 360 psi
- b. Design Pressure for NPS 2-1/2 (DN 65) through NPS 6 (DN 150): ANSI 125, Class B
- c. Close-off Pressure for NPS 2 (DN 50) and Smaller: 200 psi
- d. Close-off Pressure for NPS 2-1/2 (DN 65) through NPS 6 (DN 150): 100 psi
- e. Design Temperature: Between 14°F to 250°F
- f. Pressure independent operation up to system delta-p of 50 psid minimum; maximum pressure drop of 5.0 psid at design flow.
- g. A characterized control valve shall be integrated with an ultrasonic flow meter providing analog flow feedback. The valve shall reposition to maintain the required flow with +/- 5% accuracy The flow meter shall incorporate an algorithm to automatically calculate the glycol concentration and be readable by a local device, BACnet or MODBUS.
- h. Leakage 0%; equal percentage flow characteristic.
- i. Body; NPS 2 (DN 50) and Smaller: Forged brass, nickel plated with NPT female ends; stainless steel ball and stem, PTFE seats, Teflon characterizing disc.
- j. Body; NPS 2-1/2 (DN 65) through NPS 6 (DN 150): Cast iron with pattern to mate with ANSI 125 flange, stainless steel ball and stem, PTFE seats, stainless steel characterizing disc.
- k. Acceptable Manufacturers:
  - 1) Flow Control Industries
  - 2) Belimo
  - 3) Tour Anderson
  - 4) Bray
  - 5) Danfoss

## 2.21 VALVE ACTUATORS

### A. General:

- 1. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.
- 2. Provide visual position indication.
- 3. Mount actuator directly on valve or provide linear motion assembly as required for valve type.

B. Valve Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Valves: Where shown on the drawings or sequences, fail-safe mechanism shall operate the valve to the fail position following power interruption.
  - a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
  - b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 2 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.

## 2.22 CONTROL INSTRUMENTATION

A. Temperature Measuring Devices:

1. Electric Thermostats:
  - a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.
  - b. Single Temperature - Low Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, anticipator circuits, concealed temperature adjustment, locking cover, 24 V control transformer (if not included with unit under control), single or double pole as required.
2. Low Limit Switch:
  - a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.
  - b. Provide 3" minimum radius capillary support clips at each turn.
  - c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.
  - d. Setpoint range shall be 15°F to 55°F with a permanent stop at 35°F.
  - e. Differential shall be fixed at approximately 5°F and supplied with manual reset.

B. Temperature Sensors:

1. Room Temperature Sensor:

- a. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, no setpoint adjustment or override button.
- b. Sensor with Setpoint Adjustment: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a single warmer/cooler or red/blue visual scale), no override button.
- c. Sensor with Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, occupied/unoccupied override button with LED, no setpoint adjustment.
- d. Sensor with Setpoint Adjustment and Override: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, with exposed single setpoint adjustment (no numeric temperature scale - provide with a warmer/cooler or red/blue visual scale), occupied/unoccupied override button with LED.

2. Duct Temperature Sensor:

- a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

3. Water Temperature Sensor:

- a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.

C. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

- 1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
- 2) Accuracy shall be  $\pm 3\%$  of full scale maximum throughout entire range at 70°F.
- 3) Provide mounting brackets, probes, and shutoff valves required for proper installation.
- 4) The range and service shall be as required for application or as noted on the drawings.
- 5) The range and services shall be as follows:
  - a) 0-2".
- 6) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
- 7) Provide latching relays that require manual reset once activated.
- 8) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

2. Pressure Transmitters/Transducer:

a. Air-to-Air:

- 1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:
  - a) Accuracy:  $\pm 1.0\%$  FS
  - b) Non-Linearity, BFS:  $\pm 0.96\%$  FS
  - c) Hysteresis:  $0.10\%$  full scale
  - d) Non-Repeatability:  $0.05\%$  full scale
  - e) Thermal Effects (compensated range):  $0^{\circ}\text{F}$  to  $+150^{\circ}\text{F}$
  - f) Maximum Line Pressure: 10 PSI
  - g) Zero/Span Shift:  $0.033\%$ FS/ $^{\circ}\text{F}$
  - h) Long Term Stability:  $0.5\%$ FS/1year

b. Wet-to-Wet (uses include measuring hydronic system differential pressure for VFD control):

- 1) Unidirectional pressure range selected for appropriate range based on the application.
- 2) Provide transducer with minimum 250 psi high side proof pressure and minimum 60 psi low side proof pressure.
- 3) Case shall be constructed of stainless steel/aluminum and shall be equipped with 1/4" threaded connections. Wetted parts shall be constructed of 300 series stainless steel. Provide transducer with Viton and silicone O-rings for solutions containing water and/or glycol. Provide transducer with Buna-N O-rings for hydrocarbon solutions.
- 4) Provide transducer with factory assembled 3-valve manifold assembly to allow for field calibration of transducer.
- 5) Performance shall be as follows:
  - a) Accuracy:  $\pm 0.25\%$  F.S.
  - b) Non-Linearity:  $\pm 0.20\%$  F.S.
  - c) Hysteresis:  $0.10\%$ F.S.
  - d) Non-Repeatability:  $0.05\%$  F.S.
  - e) Compensated Temp Range:  $+30^{\circ}\text{F}$  to  $+150^{\circ}\text{F}$
  - f) Long Term Stability:  $0.5\%$  F.S./year

3. Room Pressure Indicator:

a. General:

- 1) The room pressure monitor system shall include a room pressure monitor, pressure sensor, and low voltage control transformer.
- 2) The system shall continuously measure, display, and monitor the room pressure.
- 3) All components of the room pressure indicator shall be completely designed, tested, cataloged, and coordinated for single point responsibility.
- 4) Display shall be visual color indicator with pressure readout.
- 5) TCC shall furnish and install all wiring as required to connect system components.



- b. Room Pressure Monitor:
  - 1) Shall measure and display room pressure. Refer to drawings for room pressure monitor locations.
  - 2) A minimum of two indicator colors shall be provided on the front of the monitor to indicate ALARM (red) and NORMAL (green) conditions.
  - 3) There shall be an alphanumeric digital display indicating the measured room pressure in inches of H<sub>2</sub>O with a display accuracy of 0.001 and shall be updated every second.
  - 4) Provide the following inputs/outputs to the FMCS system:
    - a) Pressure (analog).
- c. Pressure Sensor:
  - 1) Shall be temperature compensated over a range of 55°F to 95°F.
  - 2) The assembly shall not compromise the fire rating of the wall.
  - 3) Shall measure room pressure from -0.20000 to +0.20000 inches H<sub>2</sub>O with an accuracy of ± 0.001 inches H<sub>2</sub>O.
  - 4) Shall be bidirectional to determine the proper direction of pressure. Unidirectional sensors are not acceptable.
  - 5) Manufacturer shall provide cable between the pressure sensor and room pressure monitor.

#### D. Flow Measuring Devices:

- 1. Flow Switches:
  - a. Suitable for the intended application (water or air system).
  - b. Vane Operated Flow Switch: Vane motion shall activate a single pole, double throw snap switch.
- 2. Inline Electromagnetic Flow Meters:
  - a. General:
    - 1) Each flow meter shall be of the electromagnetic type.
  - b. Service:
    - 1) Chilled Water: Rated for 32°F through 140°F service.
    - 2) Condensate and Heating Water: Rated for minimum of 240°F service.
  - c. Electromagnetic Flow Tube:
    - 1) Each meter shall be rated for system pressure and shall have adequate structural integrity for a flow rate equal to 150% of the scheduled maximum initial or future flow rate, whichever is greater.
    - 2) Each meter shall have flanged connections to match piping pressure class, an outer body constructed of painted carbon steel, a full line-size 304 stainless steel flow tube, 316 stainless steel electrodes, and a liner that is fully compatible with the chemical content of the flow media.
    - 3) Each meter shall be provided with an adequate means for grounding the process fluid (e.g., grounding rings or a grounding electrode).

- d. Transmitter:
- 1) Each meter shall incorporate an integral programmable transmitter that incorporates a digital display. For remote mounted transmitters, 25 foot minimum cable length shall be provided with each unit unless otherwise scheduled or noted within the documents. The cable length shall be adequate to satisfy specific installation requirements.
  - 2) Each transmitter shall calculate and display flow rate and net totalized flow, along with associated engineering units (e.g., GPM and Gal.).
  - 3) Each transmitter shall produce an analog output signal that is directly proportional to volumetric flow rate. This signal shall be scalable to indicate flow rate in either direction. In lieu of such bidirectional scalability, two separate pulsed outputs shall be provided. One shall indicate incremental flow in one direction, while the other indicates incremental flow in the opposite direction such that net totalized flow can be calculated remotely.
  - 4) Unless scheduled or otherwise indicated, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.
  - 5) Each transmitter shall incorporate self-diagnostics and test functions to permit internal checks of all outputs and displays, and to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
- e. Accuracy:
- 1) Non-billing Purposes: The accuracy of each meter/transmitter assembly shall be  $\pm 0.5\%$  of flow rate reading over a range of 3-15 feet/second fluid velocity, with a repeatability of 0.1%. Accuracy at 1 foot/second shall be  $\pm 0.75\%$ .
- f. Display Unit:
- 1) Pair with Display Unit described below.
- g. BTU Meter:
- 1) Pair with BTU Meter described below.
- h. Calibration:
- 1) Each meter shall be calibrated on an NIST traceable flow stand at 1, 8, and 15 feet/second. Provide written documentation of calibration.
  - 2) Billing Purposes: Each meter shall have factory fingerprinting to allow NIST traceable in-situ calibration verification to  $\pm 1\%$  of original factory calibration.
- i. Installation and Startup:
- 1) Each meter assembly shall include detailed installation and operation instructions, including piping straight run requirements.
  - 2) Provide on-site startup, commissioning, and training.

## j. Warranty:

- 1) Each meter assembly shall carry a performance warranty of at least two years from the date of installation and startup. This warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.

## k. Manufacturers:

- 1) ABB
- 2) Yokogawa
- 3) Rosemount
- 4) Onicon
- 5) Badger.

## 3. Insertion Type Vortex Flow Meters:

## a. General:

- 1) Each flow meter shall be an insertion type vortex style flow meter for volumetric or mass flow.

## b. Service:

- 1) Steam, high temp liquid and gas flows: Rated from -300°F to 750°F service.

## c. Construction:

- 1) Wetted materials constructed of 316 stainless steel.
- 2) Connection: Flanged.
- 3) Each meter shall be wet calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST.
- 4) FM Class I, Div. 1 Groups B, C, D.

## d. Output:

- 1) Each transmitter shall produce an analog output signal, 4-20 mA that is directly proportional to volumetric flow rate.
- 2) Alarm: Solid state relay, 40VDC
- 3) Totalizer Pulse: 50 millisecond pulse, 40VDC.
- 4) Volumetric or LP Mass: One analog, one totalizer pulse, Hart.
- 5) Multi-variable: Up to 3 analog signals, 3 alarms, one totalizer pulse, HART.
- 6) Modbus or BACnet process monitoring.
- 7) Turndown up to 100:1.
- 8) The output shall be connected with display unit.
- 9) All wire shall be carried into 1/2" NPTM conduit connection. The meter shall include 25 feet of cable to connect with a remotely mounted display unit.
- 10) Unless scheduled or indicated otherwise, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.

## e. Accuracy:

- 1) Volumetric Flow Rate: Liquids -  $\pm 0.7\%$  of rate; Gas/Steam -  $\pm 1\%$  of rate.
- 2) Mass Flow Rate: Liquids -  $\pm 1.0\%$  of rate; Gas/Steam -  $\pm 1.5\%$  of rate.

- 3) Temperature: Liquids -  $\pm 2.0^{\circ}\text{F}$  of rate; Gas/Steam -  $\pm 2.0^{\circ}\text{F}$ .
- 4) Pressure: Liquids -  $\pm 3.0\%$  of full scale; Gas/Steam -  $\pm 3.0\%$  of full scale.
- 5) Density: Liquids -  $\pm 0.3\%$  of reading; Gas/Steam -  $\pm 0.5\%$  of reading.

f. Repeatability:

- 1) Volumetric Flow Rate:  $\pm 0.2\%$  of rate.
- 2) Mass Flow Rate:  $\pm 0.2\%$  of rate.
- 3) Temperature:  $\pm 2^{\circ}\text{F}$ .
- 4) Pressure:  $\pm 0.05\%$  of full scale.
- 5) Density:  $\pm 0.1\%$  of reading.

g. Display Unit:

- 1) Pair with display unit described below.

h. BTU Meter:

- 1) Pair with BTU Meter described below.

i. Calibration:

- 1) Each meter shall be calibrated on an NIST traceable flow stand at 1, 8, and 15 feet/second. Provide written documentation of calibration.
- 2) Billing Purposes: Each meter shall have factory fingerprinting to allow NIST traceable in-situ calibration verification to  $\pm 1\%$  of original factory calibration.

j. Warranty:

- 1) Provide performance warranty of at least two years from the date of installation and startup. Warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.

k. Manufacturers:

- 1) Armstrong AVF

4. Display Unit:

a. General:

- 1) The display shall compatible with virtually any flow meter.
- 2) The display module shall provide a local indication of liquid flow rate and net totalized flow, along with associated engineering units (e.g., GPM/second and gallons).
- 3) It shall have a network interface to communicate flow data to the building control network.
- 4) House in a steel wall-mounted enclosure with a built-in user interface/display.
- 5) Display unit shall accept 4-20 mA pulse or contact closure flow signals. It shall also function as a network interface for two (2) additional analog rate inputs and one (1) additional totalizing pulse input.
- 6) It shall support BACnetLonWorks communication protocols.

- 7) The display shall have two-line alphanumeric LCD displays of flow rate and flow total.
- 8) The display shall have non-volatile EEPROM memory that retains all program parameters and totalized values in the event of power loss.
- 9) Electrical Power Supply: 24VAC, 60Hz, 500mA max.

b. Manufacturers:

- 1) Onicon
- 2) Yokogawa
- 3) Badger.

5. BTU Meter:

a. General:

- 1) Microprocessor based thermal energy meter with LCD display.
- 2) BTU meter shall work with all common types of flow meters, temperature sensors, and pressure sensors. It shall display total energy, total flow, energy rate, flow rate, supply temperature, and return temperature.
- 3) It shall be compatible with BACnetLonWorks network interface and shall input these values to the network area controller.
- 4) It shall be suitable for liquid temperature range of 25°F to 240°F and ambient temperature range: -20°F to 140°F.
- 5) BTU meter shall have LCD display as follows:
  - a) Alpha: 16 character, 0.2" high
  - b) Numeric: 6 digit, 0.4" high
  - c) Rate Display Range: 0-9,999,999
  - d) Total display Range: 0-9,999,999
- 6) The meter shall be compatible with liquid flow signal input of 0-15 V pulse output or 4-20 mA analog output from any flow meter.
- 7) The meter shall provide output signals as follows:
  - a) Isolated solid-state dry contacts for energy total, maximum contact rating: 100 mA, 50 V.
  - b) Multiple isolated analog or digital outputs for energy rate, flow rate, supply and return temperature and delta temperature. Output type: 4-20mA, 0-10 V, or 0-5 V.
  - c) Interval Data Logging: This option provides at least 24 hours of rate and total data logging in 15-minute intervals. Data includes date/time stamp, measured value, and scaling factors when appropriate.
  - d) Network interface: BACnetLonWorks.
- 8) Electrical Input Power: 120 VAC, 60 Hz.

b. Accuracy:

- 1) The accuracy of BTU meter shall be  $\pm 0.5\%$  of flow rate reading over a range, with a repeatability of 0.1%.

## c. Warranty:

- 1) Each BTU meter assembly shall carry a performance warranty of at least two years from the date of installation and startup. This warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.

## d. Manufacturers:

- 1) Onicon
- 2) Yokogawa
- 3) Badger.

## 6. Airflow Measuring Stations:

## a. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:

- 1) Provide airflow/temperature measurement devices where indicated on the plans.
- 2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
  - a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
  - b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
  - c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
  - d) Devices using less than two thermistors in each sensor assembly are not acceptable.
  - e) Devices using platinum wire RTDs are not acceptable.
  - f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
  - g) Pitot tubes and arrays are not acceptable.
  - h) Vortex shedding devices are not acceptable.
- 3) All Sensor Probes:
  - a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.
  - b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
  - c) Airflow measuring station assembly accuracy shall be  $\pm 2\%$  of Reading over the entire operating airflow range. Temperature accuracy shall be  $\pm 0.15^\circ$  F between  $-20^\circ$  F and  $160^\circ$  F.
  - d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).

- e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
  - f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.
- 4) Duct and Plenum Probes:
- a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
  - b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.
  - c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density:

Area (sq.ft.)	Total # of Sensors Required
Less than 2	4
2 to less than 4	6
4 to less than 8	8
8 to less than 16	12
≥ 16	16

6) Transmitters:

- a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
- b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
- c) The operating temperature range for the transmitter shall be -20° F to 120° F.
- d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
- e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
- f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
- g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
- h) Option 4: LonWorks Free Topology

b. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:

- 1) Sensor assemblies shall be mounted on 304 stainless steel housings.
- 2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
- 3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.
- 4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
- 5) Transmitters
  - a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
  - b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
  - c) The operating temperature range for the transmitter shall be -20° F to 120° F.
  - d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
  - e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
  - f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
  - g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
  - h) Option 4: LonWorks Free Topology
- 6) The AFMS shall be UL listed as an entire assembly.

c. Fan Inlet Airflow Measuring Stations - Differential Pressure:

- 1) Fan Inlet Measuring Station Pressure Sensors, Transmitters and Transducers:
  - a) Select for appropriate pressure range, fan type, inlet velocity, and airflow volume.
  - b) Transmitter features and minimum performance requirements shall be as follows: (1) Combined Accuracy:  $\pm 0.50\%$ , (2) Terminal Point Nonlinearity:  $\pm 0.40\%$ , (3) Hysteresis:  $\pm 0.02\%$ , (4) Non-repeatability:  $\pm 0.05\%$ , (5) Compensation Range - Zero Shift:  $\pm 0.025\%$  FS/°F, Span Shift:  $0.025\%$  FS/°F, (6) Differential Overpressure: 5 psi proof and 25 psi burst pressure, (7) Output signal: 0 to 10 VDC.
  - c) Each transducer shall be provided with an integral manual zeroing valve to allow for field calibration of the zero-reference value without the need for shutting the operating system down.
  - d) System airflow (measured in CFM) shall be continuously displayed on an LCD display meter (0.5 inches high by 3.5 digits) located on the face of the air volume/velocity transducer control enclosure.



- d. Mounting of fan inlet static pressure sensing elements shall be in accordance with manufacturer's published installation instructions to ensure accuracy of readings.

E. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:
  - a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.
2. Current Switches for Motors Controlled by VFD:
  - a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

F. Occupancy Sensors:

1. Use auxiliary contacts on sensor provided and installed by the Electrical Contractor. Refer to electrical drawings for sensor location and specifications. Coordinate with Electrical Contractor.
2. Ceiling mounted, dual technology: sonic and passive infrared, 360° coverage pattern, zero crossing circuitry, adjustable sensitivity and time delay (initial setting: Time delay - 5 minutes unless noted otherwise below, integral isolated relay with normally open and normally closed outputs, LED indicator, five-year warranty, UL listed. TCC shall submit manufacturer supplied sensor layout drawing for shop drawing review. Provide full room coverage as recommended by manufacturer.
3. Space Occupancy Initial Setting Schedule
4. Initial Time
5. Space Delay Setting
6. Reception 20 minutes

G. Carbon Monoxide Sensors:

1. Solid-state gas sensor/transmitter, NEMA 1 gasketed enclosure, normal operating temperature 0-120°F, normal relative humidity operation 5-95%, ± 5% accuracy, and detection range of 0-200 ppm.
2. Provide 4-20 mA output from the sensor to the FMCS system.
3. Provide local alarm whenever carbon monoxide level exceeds 100 ppm.
4. It shall be compatible with BACnetLonWorks network interface and shall input these values to the network area controller.
5. Install in accordance with OSHA requirements.
6. Unit shall be factory calibrated and shall be re-calibrated after installation per manufacturer's recommendations.

H. Miscellaneous Devices:

1. Application Specific Controller Power Supply:
  - a. For use with terminal air box, unit heaters, pumps.
  - b. Provide multiple enclosures with the following accessories and components as required to provide 24VAC power to terminal air boxes, differential pressure monitors, damper actuators, valve actuators, and other components and devices as required.
  - c. NEMA-1 steel enclosures (12"x12"x6") with separate high and low voltage compartments and separate access covers.
  - d. Either two 300 VA power supply with three 100 VA Class 2 outputs, or one 500 VA power supply with five 100 VA Class 2 outputs.
  - e. Primary side shall receive 480/277/240/120 input to 24 VAC ungrounded, isolated output on the secondary side.
  - f. Each secondary output shall include a 4 amp breaker, on/off switch, and LED indicator. Terminal blocks shall accept 16-22 AWG wire.
  - g. Acceptable Manufacturer:
    - 1) RIB Functional Devices Model MSH300A-LVC or PSH500A-LVC
2. Control Relays:
  - a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
  - b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.
3. Thermostat and Sensor Enclosures:
  - a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards in all corridors, gymnasiums, locker rooms, toilet rooms, assembly halls and as noted on the drawings.
4. Twist Timers:
  - a. Wall-mounted heavy duty, with rotary dial and face graduated in minutes or hours as noted. Unit shall fit behind standard "decorator" wall plate. Color of timer and face plate shall match remainder of project. Verify with Electrical Contractor. Provide wall plate and engraved plastic label indicating service.
  - b. Switch shall be rated for 20 amps at 125 volts (10 amps at 277 volts) and fit standard 2-1/2" deep electrical box.
  - c. Provide time cycle noted on the drawings or in the specifications; up to 12 hours.
  - d. Manufacturers:
    - 1) Paragon SWD Series
    - 2) Tork A500 Series
    - 3) Intermatic FD Series
    - 4) Marktime Series 93
5. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. No standby power required.

- I. Outdoor Weather Station:
  - 1. Outdoor rated ventilated plastic enclosure, off-white color, radiation shield including the following parameters.
  - 2. Measured Parameters:
    - a. Temperature Sensor: Thermistor sensing element or resistance temperature device (RTD).
      - 1) Operating Range: -40°F to 140°F
      - 2) Accuracy:  $\pm 0.54^{\circ}\text{F}$  at 68°F
  - 3. Calculated Parameters:
    - a. Dew Point Temperature in °F
    - b. Wet Bulb Temperature in °F
    - c. Enthalpy. Enthalpy sensor shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

## 2.23 CONDUIT AND BOXES

- A. Conduit and Boxes: Refer to Electrical Section 260533 for materials, sizing, and other requirements.
- B. Conduit and Box Identification (Color and Labeling):
  - 1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
  - 2. Refer to Electrical Section 260553 for raceway and box labeling requirements.

## 2.24 WIRE AND CABLE

- A. Wire and Cable: Refer to Electrical Section 260513 for wire and cable materials.
  - 1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.

- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.
- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the optional standby branch of emergency power. In no instance shall panel be connected to the life safety or critical branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Labels For Control Devices:
1. Provide labels indicating service of all control devices in panels and other locations.
  2. Labels may be made with permanent marking pen in the control panels if clearly legible.
  3. Use engraved labels for items outside panel such as outside air thermostats.

4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

N. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.
5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

O. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.
2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.
3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.
4. Install labels at each sensor and transmitter identifying its service.

### 3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
  1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
  2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
  3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
  4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
  5. Show the location of each thermostat on the floor plan.
  6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.

7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
  2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
  3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
  4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
  2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
  3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

### **3.3 CONDUIT AND BOXES INSTALLATION**

- A. Conduit and Box Installation: Refer to Electrical Section 260533 for execution and installation.
- B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 260553 for raceway and box identification installation.
- C. Outlet Box Schedule: Thermostat/temperature sensor:
1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
  2. Other Conditions: Refer to Electrical Section 260533 for requirements.

### **3.4 WIRE AND CABLE INSTALLATION**

- A. Wire and Cable Installation: Refer to Electrical Section 260513 for execution and installation.
- B. Field Quality Control:
1. Inspect wire and cable for physical damage and proper connection.
  2. Torque test conductor connections and terminations to manufacturer's recommended values.
  3. Perform continuity test on all conductors.

4. Protection of cable from foreign materials:
  - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
  - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

### 3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

### 3.6 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.
- E. Verify the operation of all interlock systems.

### **3.7 TEST AND BALANCE COORDINATION**

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

### **3.8 DEMONSTRATION AND ACCEPTANCE**

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

### **3.9 TRAINING**

- A. On-Site:
  - 1. After completion of commissioning, the manufacturer shall provide 8 hours of training on consecutive days for 4 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

### **3.10 INSTALLATION OF SENSORS**

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.
- F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.



- G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.
- H. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

**3.11 INSTALLATION OF FLOW METERS**

- A. Provide manufacturer's recommended lengths of straight piping upstream and downstream of the flow meter. Up to 30 diameters upstream of the flow meter may be required depending on the piping arrangement and flow meter type.
- B. Maintain adequate pull/service space.

END OF SECTION 230900

**SECTION 230913 - INSTRUMENTATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Pressure Gauge.
- B. Pressure Gauge Accessories.
- C. Thermometers.
- D. Test Plugs.
- E. Static and Differential Airflow Pressure Gauges.

**1.2 SUBMITTALS**

- A. Submit shop drawings per Section 230500. Include list that indicates use, operating range, total range and location for manufactured components.

**PART 2 - PRODUCTS****2.1 PRESSURE GAUGES**

- A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for air, steam, water or oil application, 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.
- B. Manufacturers:
  - 1. Ashcroft
  - 2. Marsh
  - 3. Marshalltown
  - 4. Miljoco
  - 5. Trerice
  - 6. U.S. Gauge Figure 1901
  - 7. Weiss
  - 8. Weksler
  - 9. Wika.
- C. Manufacturer:
  - 1. Ashcroft
  - 2. Marshalltown
  - 3. Marsh
  - 4. Miljoco
  - 5. Trerice
  - 6. U.S. Gauge Figure 1980
  - 7. Weiss

8. Weksler
9. Wika.

D. Select gauge range for normal reading near center of gauge.

## 2.2 PRESSURE GAUGE ACCESSORIES

- A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.
- B. Shutoff Valve: 1/2" ball valve as specified for each piping system.
- C. Pressure snubber, brass with 1/2" connections, porous metal type.
- D. All pressure gauge piping shall be minimum 1/2" 304 stainless steel pipe or copper tube.

## 2.3 THERMOMETERS

A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
3. Stem lengths as required for application with minimum insertion of 2-1/2".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
5. Manufacturer:
  - a. Ashcroft
  - b. Marsh
  - c. Marshalltown
  - d. Miljoco
  - e. Tel-Tru
  - f. Trerice
  - g. U.S. Gauge
  - h. Weiss
  - i. Weksler, Wika.

B. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.
2. Select thermometer for appropriate temperature range.
3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.

## 5. Manufacturer:

- a. Marsh
- b. Miljoco
- c. Trerice
- d. Weiss
- e. Weksler
- f. Wika.

## C. Digital Type:

1. 1/2" LCD digital display, solar powered, with high impact ABS case. Accuracy of 1% of reading or 1°F, whichever is greater. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
2. Fahrenheit/Celsius switchable with -50/300°F range.
3. Through-case potentiometer recalibration adjustment.
4. Stem lengths as required for application, with minimum insertion of 2-1/2".
5. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
6. Digital display shall operate at 10 Lux (one foot-candle) or more. Use this thermometer only where ambient temperatures are below 140°F and there is sufficient light under normal occupied space conditions for the digital display to function. Use a different type thermometer where there is inadequate light available (i.e., dark mechanical rooms, locations where the thermometer is shielded from light, etc.).
7. Manufacturer:
  - a. Miljoco
  - b. Trerice
  - c. Weiss
  - d. Weksler
  - e. Wika.

**2.4 TEST PLUGS**

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.

**2.5 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES**

- A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
- B. Accuracy shall be  $\pm 3\%$  of full scale maximum throughout entire range at 70°F.
- C. Provide mounting brackets, probes, and shutoff valves required for proper installation.
- D. The range and service shall be as required for application or as noted on the drawings.

- E. Manufacturers:
1. Dwyer Magnehelic Series 2000
  2. Marshalltown Instrument Series 85C.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General Installation Requirements:
1. Install per manufacturer's instructions.
  2. Coil and conceal excess capillary on remote element instruments.
  3. Install gauges and thermometers in locations where they are easily read from normal operating level.
  4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Pressure Gauges:
1. Connect pressure gauges to suction and discharge side of all pumps.
  2. Provide 1/2" tubing for pressure gauge and gauge accessories.
  3. Provide snubber for each pressure gauge.
  4. Provide coil syphon for each pressure gauge connected to steam piping.
- C. Thermometers:
1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
  2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.
  3. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION 230913

**SECTION 232100 - HYDRONIC PIPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Pipe and Pipe Fittings
- B. Valves
- C. Check Valves
- D. Strainers
- E. System Piping Schedule

**1.2 QUALITY ASSURANCE**

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

**1.3 REFERENCES**

- A. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.
- B. ASME - Boiler and Pressure Vessel Code.
- C. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- D. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- H. ASME B16.51 - Copper And Copper Alloy Press-Connect Pressure Fittings.
- I. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
- J. ASME B18.2.2 - Square and Hex Nuts, Inch Series.
- K. ASME Section 9 - Welding and Brazing Qualifications.
- L. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

- M. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- N. ASTM F3226 - Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems.

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 230500. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

#### **1.6 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### **PART 2 - PRODUCTS**

#### **2.1 STEEL PIPE (ABOVE GRADE)**

- A. Design Pressure 125 psig, Maximum Design Temperature 225°F (230°F for grooved couplings).
- B. Black Steel; Standard Weight; Threaded Joints:
  1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53; Type E, F, or S; Grade B.
  2. Joints: Screwed.
  3. Fittings: Class 125 cast iron, ASTM A126, ASME B16.4; or Class 150 malleable iron, ASTM A197, ASME B16.3.
  4. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.
- C. Black Steel; Standard Weight; Welded or Flanged Joints:
  1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.
  2. Joints: Butt-welded or flanged.
  3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.
  4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges. Flange face seal weld (backweld) is required for slip-on flanges.
- D. Black Steel; Standard Weight; Mechanically Coupled Grooved Joints:
  1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.

2. Joints: Grooved type, with Grade E EPDM molded pressure-responsive gaskets suited for 32°F to 230°F per ASTM D2000.
    - a. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support. Design Basis: Victaulic 107N.
      - 1) Usage: All locations unless noted elsewhere.
    - b. Flexible Type: Housing cast with horizontal, angle-pattern bolt pads to provide vibration attenuation and stress relief. Design Basis: Victaulic 177N.
      - 1) Usage: first three joints adjacent to vibrating equipment (e.g., chillers, boilers, pumps, air handling equipment, etc.).
  3. Fittings: ASTM A536 Grade 65-45-12 ductile or A47 malleable iron, grooved type.
  4. Flanges: Grooved end, flanged adapter.
- E. Black Steel; Standard Weight; Mechanical Press Connection:
1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.
  2. Joints: Mechanical press connection.
  3. Fittings: ASTM F3226 with O-ring gaskets as described below:
    - a. EPDM gaskets/sealing element for sizes through 2" in diameter.
    - b. FKM gaskets/sealing element for sizes through 4" in diameter.
  4. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
  5. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
  6. Manufacturers:
    - a. Viega MegaPress
    - b. NIBCO BenchPress
    - c. Mueller Streamline
- F. Galvanized Steel; Schedule 40; Threaded Joints:
1. Galvanized Steel Pipe: ASTM A53, Schedule 40 galvanized.
  2. Fittings: Galvanized cast iron screwed drainage type, ASME B16.12.
  3. Joints: Screwed.
  4. Service: Not allowed on boiler drains and overflow.
- G. Black Steel; Standard Weight; Welded:
1. Design Pressure: 125 psi. Maximum Design Temperature: 1000°F
  2. Pipe: Standard weight black steel, beveled ends, ASTM A53.
  3. Joints: Butt welded.
  4. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade WPB, ANSI B16.9.



## 2.2 COPPER PIPE (ABOVE GRADE)

- A. Design Pressure 125 psig. Maximum Design Temperature 225°F.
- B. Copper Pipe; Type L; Soldered Joints:
1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
  2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
  3. Fittings: Wrought copper solder joint, ASME B16.22.
  4. Copper Pipe; Type L; Mechanical Press Connection: Tubing: Type L hard drawn seamless copper tube, ASTM B88.
  5. Joints: Mechanical press connection.
  6. Fittings: Copper, ASME B-16.51, with embedded EPDM O-ring, NSF-61.
  7. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
  8. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
  9. Manufacturers:
    - a. Viega ProPress.
    - b. Elkhart Xpress.
    - c. NIBCO Press System Fittings and Valves.
    - d. Mueller Streamline PRS.
- C. Copper Pipe; Type L; Mechanically Coupled Grooved Joints:
1. Pipe: Type L hard drawn seamless copper tube, ASTM B88, roll grooved per mechanical coupling manufacturers specifications.
  2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
  3. Joints: Mechanically coupled grooved type.
    - a. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support. Design Basis: Victaulic 107N.
      - 1) Usage: All locations unless noted elsewhere.
    - b. Flexible Type: Housing cast with horizontal, angle-pattern bolt pads to provide vibration attenuation and stress relief. Design Basis: Victaulic 177N.
      - 1) Usage: first three joints adjacent to vibrating equipment (e.g., chillers, boilers, pumps, air handling equipment, etc.).
  4. Mechanical Couplings: Ductile iron, ASTM A-536, (Grade 65-45-12), rigid grooved type, coated with non-toxic, no-lead paint, bolts and hex nuts zinc electroplated plated, ASTM B-633
  5. Gaskets: Molded pressure responsive design, EPDM Grade E, ASTM D-2000, suitable for domestic water with temperatures ranging from 32°F to 230°F (.).
  6. Fittings: Copper, ASTM B-75 and ANSI B-16.22, Full flow wrought copper, manufactured by mechanical coupling manufacturer
  7. Flanges: Grooved end type, Ductile iron, ASTM A-536, (Grade 65-45-12), Flange shall conform to ANSI Class 125 cast iron and Class 150 steel flange bolt hole pattern, coated with non-toxic, no-lead paint, bolts and hex nuts zinc electroplated plated, ASTM B-633.

8. Manufacturers:
    - a. Gruvlok
    - b. Victaulic
    - c. Grinnell
  9. Copper; Type M; Mechanical Press Connection: Tubing: Type M (or thicker) drawn temper seamless copper tube, ASTM B88.
  10. Joints: Mechanical press connection.
  11. Fittings: Copper, ASME B-16.51, with embedded EPDM O-ring, NSF-61.
    - a. In sizes where drainage type fittings are not available, tees with threaded caps to permit rodding are acceptable.
  12. Limitations: Equipment drains and overflows only. No pressure pipes.
  13. Fitting Identification: Press ends shall provide the ability to identify an unpressed fitting from the floor prior to testing. The function of this feature is to provide the installer quick and easy identification of connections that have not been pressed prior to putting the system into operation.
  14. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
  15. Manufacturers:
    - a. Viega ProPress
    - b. Elkhart Xpress
    - c. NIBCO Press System Fittings and Valves
    - d. Mueller Streamline PRS
- D. Copper; DWV; Soldered:
1. Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306.
  2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
  3. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.

## 2.3 VALVES

- A. Shutoff Valves:
1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
  2. Ball Valves:
    - a. BA-1 (Steel and Copper): 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.
      - 1) Manufacturers:
        - a) Apollo #77C-140
        - b) Stockham #S-206 BR1-R
        - c) Milwaukee #BA-400
        - d) Watts
        - e) Nibco #585-70-66

- f) National Utilities Co.
  - g) RUB.
- 2) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
  - 3) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
3. Butterfly Valves:
- a. BF-1:
    - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.
    - 2) Manufacturers:
      - a) Center Line Series 200
      - b) Keystone #222
      - c) Watts #DBF-03-121-1P
      - d) Nibco N200 Series or LD2000 Series
      - e) Milwaukee CL series
      - f) Hammond 5200 series.
    - 3) Mechanically coupled grooved end valves are acceptable if they have the temperature ratings, pressure ratings, and features listed above.
    - 4) Manufacturers:
      - a) Victaulic #300
      - b) Nibco GD4765

## 2.4 THROTTLING VALVES

### A. Throttling Valves (Steel):

1. Ball Valves (Steel and/or Copper):
  - a. BA-9: 2" and under, 125 psi saturated steam, 600 psi WOG, standard port, screwed (solder ends are acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body and ball of copper alloy containing less than 15% zinc, chrome plated or stainless steel ball, Teflon seats and seals with memory stop.

- 1) Manufacturers:
  - a) Apollo #70-120
  - b) Stockham #S-216BR-R
  - c) Milwaukee #BA-100
  - d) Watts #B-6000
  - e) Hammond #8501
  - f) Nibco #580-70.

2. Butterfly Valves:

a. BF-4:

- 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.
- 2) Manufacturers:
  - a) Victaulic #300
  - b) Center Line Series 200
  - c) Keystone #222
  - d) Watts #DBF-03-121-1P
  - e) NIBCO LD2000 Series
  - f) Milwaukee CL Series
  - g) Hammond 5200 Series
- 3) Manufacturers:
  - a) Center Line Series 200
  - b) Keystone #222
  - c) Watts #DBF-03-121-1G
  - d) NIBCO LD2000 Series
  - e) Victaulic #300
  - f) Milwaukee CL Series
  - g) Hammond 5200 Series

**2.5 LOCK OUT TRIM**

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

**2.6 CHECK VALVES**

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

- B. CK-1: Check Valves (Steel Pipe); 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing.
1. Manufacturers:
    - a. Crane #37
    - b. Hammond #IB904
    - c. Walworth #406
    - d. Milwaukee #509
    - e. Watts #B-5000
    - f. or NIBCO #T-413.
- C. CK-13: Check Valves (Steel Pipe); 2-1/2" thru 12", 200# WOG, double disc wafer type, non-slam silent check, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.
1. Manufacturers:
    - a. Milliken 740G
    - b. NIBCO W-920-W
    - c. Crane Duo-Chek
    - d. Victaulic V715
- D. CK-4: Check Valves (Copper Pipe); 2" and under, 200 psi WOG @ 150°F, solder, bronze, horizontal swing.
1. Manufacturers:
    - a. Crane #1342
    - b. Hammond #IB912
    - c. Walworth #406SJ
    - d. Milwaukee #1509
    - e. Watts #B-5001
    - f. NIBCO #S-413.

## 2.7 STRAINERS

- A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. ST-1: Bronze body, screwed ends, screwed cover, 125 psi S @ 353°F, 200 psi WOG @ 150°F
1. Manufacturers:
    - a. Armstrong #F4SC
    - b. Metraflex #TS
    - c. Mueller Steam Specialty Co. #351
    - d. Sarco #BT
    - e. Watts #777
    - f. NIBCO T-122-A.

- C. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F.
1. Manufacturers:
    - a. Armstrong #A1FL
    - b. Metraflex #TF
    - c. Mueller Steam Specialty Co.#758
    - d. Sarco #CI-125
    - e. Watts #77F-D
    - f. Victaulic #732 or #W732
    - g. NIBCO F-721-A.
- D. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:
1. Pipe Size:
    - a. 1/4" - 2": 1/32" screen
    - b. 2-1/2" - 8": 1/16" screen
    - c. 10" and Up: 1/8" screen
- E. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.
- F. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 232500 for treatment.

#### **3.2 SYSTEMS, PIPING, AND VALVE SCHEDULE**

- A. Heating Water (Above Grade - maximum 200°F unless noted otherwise below):
  1. Black Steel; Standard Weight; Threaded Joints: 2" and Under
  2. Copper Pipe; Type L; Soldered Joints: 2" and Under
  3. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
  4. Black Steel; Standard Weight, Mechanical Press Connection: 4" and Under
  5. Black Steel; Standard Weight; Welded or Flanged Joints: 2-1/2" and Over
  6. Black Steel; Standard Weight; Grooved Joints: 2-1/2" and Over
  7. Copper Pipe; Type L; Grooved Joints: 2-1/2" and Over
  8. Polypropylene; Maximum SDR 7.3; Socket or Electrofusion: All Sizes maximum of 185°F.

9. Shutoff Valves: BA-1, BA-1A (STEEL), BF-1, BF-5
10. Throttling Valves: BA-9
11. Check Valves: CK-1, CK-4, CK-13
12. Strainers: ST-1, ST-2

B. Equipment Drains and Overflows:

1. Copper; DWV; Soldered: 4" (200 mm) and Under
2. Copper; Type M; Mechanical Press Connection: 4" (200 mm) and Under

### 3.3 TESTING PIPING

- A. Test pipes underground or in chases and walls before piping is concealed.
- B. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.
- C. Test the pipe with water at 1.5 times the design pressure but not less than 125 psig pressure. Hold pressure for at least two hours.
- D. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

### 3.4 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.
2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.
3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.

4. After each system has been cleaned and thoroughly flushed of pretreatment chemicals, it shall be immediately refilled with water and treated with chemical treatment as specified in Section 232500. The system shall not be allowed to sit empty for any length of time.
5. When system water is clear, remove, clean and replace all strainers.
6. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 232500, shall be repeated at the Contractor's expense.
7. Chemical cleaning applies to the following systems:
  - a. Heating Water

### 3.5 INSTALLATION

#### A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
2. Install piping to conserve building space, and not interfere with other work.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
6. Install bell and spigot pipe with bells upstream.
7. Seal pipes passing through exterior walls with a wall seal per Section 230529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

#### B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

#### C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
3. Provide clearance for installation of insulation, and access to valves and fittings.
4. Prepare pipe, fittings, supports, and accessories for finish painting.
5. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
6. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
7. Provide flanges or unions at all final connections to equipment, traps and valves.
8. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.



9. Horizontal swing check valves may only be installed in horizontal position. Do not install horizontal swing check valves in upward or downward flow direction. Where upward or downward flow installation is required, use spring-assisted, non-slam check valve.

### **3.6 PIPE ERECTION AND LAYING**

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. 2-1/2" and larger fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.
- H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

### **3.7 DRAINING AND VENTING**

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
- B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.
- C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.
- D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.

- E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.
- F. All vent and drain piping shall be of same materials and construction as the service involved.

### 3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
  1. Must have at least same pressure rating as the main.
  2. Header or main must be 2-1/2" or over.
  3. Branch line is at least two pipe sizes under header or main size.

### 3.9 JOINING OF PIPE

- A. Threaded Joints (Steel Pipe):
  1. Ream pipe ends and remove all burrs and chips.
  2. Protect plated pipe and valve bodies from wrench marks when making up joints.
  3. Apply Teflon tape to male threads.
- B. **Flanged** Joints (Steel Pipe):
  1. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.
  2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.
  3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
  4. Gaskets for flat face flanges shall be full-face type. Gaskets for raised faced flanges shall conform to requirements for "Group I gaskets" in ASME B16.5. All gaskets shall conform to ASME B16.21. Unless otherwise specified, gaskets shall meet the following requirements:
    - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
    - b. Maximum pressure rating of at least 250 psig.
    - c. Minimum temperature rating: -10°F.
    - d. Maximum temperature rating of at least 170°F for water and glycol solution systems operating 140°F and less.
    - e. Maximum temperature rating of at least 250°F for water and glycol solution systems operating above 140°F and up to 180°F.

## C. Solder Joints (Copper Pipe):

1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type conforming to ASTM B813.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove composition discs and all seals during soldering if not suitable for 470°F.

## D. Welded Joints (Steel Pipe):

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
5. Single-welded butt joints may be employed with or without the use of backing rings in all sizes. Where backing rings are not used on pumped pressurized systems, the root side of the weld shall either be chipped or ground flush with the piping wall. For services such as vents, overflows, and gravity drains, the backing ring may be eliminated, and the root of the weld need not be chipped or ground. Backing rings shall be of the material being welded.

## E. Mechanically Coupled Grooved Joints (Steel and Copper):

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal. Couplings must be installation-ready style for quick installation and no more than two-piece housings.
2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.
3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.
4. All fittings shall be provided by one manufacturer. Mixing grooved components is not acceptable.
5. Product Warranty:
  - a. Standard: One-year product warranty. A factory-trained manufacturer's representative shall visit the site for contractor training and installation observation.
    - 1) On-site Training: Manufacturer's factory trained representative shall provide training of contractor's field personnel in use of grooving tools and installation of product. Documentation of installing contractor training with manufacturer's representative shall be submitted to the Architect/Engineer.
    - 2) Job Site Visitation: Manufacturer's representative shall periodically visit job site to ensure manufacturer's installation practices are being followed.

- b. Extended 5-Year Product Warranty: Manufacturer shall provide extended 5-year warranty to replace product. Warranty shall include onsite training and inspection of all fittings by manufacturer. Manufacturer inspection report shall be provided to the Owner upon completion.
  - c. Extended 5-Year Product and Installation Warranty: Manufacturer shall provide extended 5-year warranty to replace product and any part of the system damaged as a direct result of a failure of the product. Warranty shall include onsite training and inspection of all fittings by manufacturer. Manufacturer inspection report shall be provided to the Owner upon completion.
6. Acceptable Manufacturers: Victaulic, Gruvlok, or Star Fittings.
- F. Mechanical Press Connection (Copper):
- 1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
  - 2. Fully insert tubing into the fitting and mark tubing.
  - 3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
  - 4. Joint shall be pressed with a tool approved by the manufacturer. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

### **3.10 ACOUSTICAL LAGGING**

- A. Where indicated on drawings, completely wrap pipe with lagging and seal all joints airtight with tape recommended by the lagging manufacturer to prevent acoustical leakage at joints. Overlap lagging a minimum of 2" at any joint. Overlap lagging 2" at any wall, floor, or structural deck penetration to prevent acoustical leakage.

END OF SECTION 232100

**SECTION 232116 - HYDRONIC SPECIALTIES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Automatic Air Vents
- B. Makeup Water Accessories
- C. Safety Relief Valves
- D. Self-Contained Control Valves
- E. Balancing Valves
- F. Automatic Flow Control Valves
- G. Combination Piping Packages
- H. Expansion Tank
- I. Air Separators
- J. Drain Valves and Blowdown Valves

**1.2 QUALITY ASSURANCE**

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

**1.3 REFERENCES**

- A. ASME - Boiler and Pressure Vessel Code.
- B. ASME B31.9 - Building Services Piping.
- C. ASME Section 9 - Welding and Brazing Qualifications.
- D. ASTM A536 - Standard Specification for Ductile Iron Castings
- E. ASTM B32 - Standard Specification for Solder Metal.

**1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 230500. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

**1.6 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 230500 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

**PART 2 - PRODUCTS****2.1 AIR VENTS**

- A. At end of main and other points where large volume of air may be trapped, use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.
- B. On branch lines and small heating units, use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

**2.2 AUTOMATIC AIR VENTS**

- A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet.
  - 1. Manufacturers:
    - a. B&G #87
    - b. Armstrong
    - c. Spirotherm
    - d. Taco
    - e. Watts
- B. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet.
  - 1. Manufacturers:
    - a. B&G #107
    - b. Armstrong
    - c. Spirotherm
    - d. Taco
    - e. Watts

**2.3 MAKEUP WATER ACCESSORIES**

- A. Pressure Reducing Valve:
  - 1. For water fill lines to hydronic systems.

2. Removable strainer, field adjustable discharge pressure, brass body, disc and seat, union with 1/2" or 3/4" NPT sweat connection, 125 psig maximum working pressure, 225°F maximum temperature.
3. Manufacturers:
  - a. Armstrong
  - b. Bell & Gossett
  - c. Conbraco
  - d. Thrush
  - e. Watts

B. Relief Valve:

1. For water fill lines to hydronic systems.
2. Cast iron or bronze body, 1/2" or 3/4" screwed connections, 125 psig working pressure, 225°F maximum temperature. Minimum 500,000 Btuh capacity at 30 psig. Manual test lever.
3. Manufacturers:
  - a. Armstrong
  - b. Bell & Gossett
  - c. Conbraco
  - d. Taco
  - e. Watts

C. Backflow Preventer:

1. Reduced pressure type as scheduled on the drawings.
2. Provide an air gap fitting and piping to drain.
3. If not indicated on the drawings, unit shall be same size as pipe.
4. Field test and tag units per manufacturer's instructions by a certified tester before initial operation.

## 2.4 SAFETY RELIEF VALVES

- A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250°F. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled.
- B. Manufacturers:
  1. Kunkle # 537
  2. B&G
  3. Conbraco
  4. McDonnell & Miller
  5. Watts

## 2.5 SELF-CONTAINED CONTROL VALVES

- A. Thermostatic hot water control valves, self-contained bellows, nickel-plated body with EPDM disc, stainless steel spindle, and lifetime lubricated packing gland. Gland shall be replaceable with valve in operation.
- B. Size for maximum pressure drop of 1 psi.

- C. Configuration SCCV-1: Mount sensor and operator on valve body. Provide tamperproof cover.
- D. Configuration SCCV-2: Mount operator on valve body with remote sensor and capillary connection. Provide tamperproof cover.
- E. Configuration SCCV-3: Mount actuator on valve body with remote sensor, remote operator, and capillary connections.
- F. Manufacturers:
  - 1. Danfoss
  - 2. Type RA
  - 3. Bell & Gossett
  - 4. Honeywell Braukmann
  - 5. Sterling
  - 6. Rittling

## 2.6 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units that sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
  - 1. Carrying case with handle.
  - 2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
  - 3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
- D. Valves in copper piping shall be brass or bronze.
  - 1. Quarter-Turn Ball Valve Style (Brass or Bronze):
    - a. Manufacturers:
      - 1) Bell & Gossett "Circuit Setter Plus"
- E. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Option to balancing valves noted above are flow sensors specified in Section 230900 with a specified throttling valve.
  - 1. Quarter-Turn Ball Valve Style (Ferrous Piping  $\leq$  2"):
    - a. Manufacturers:
      - 1) Bell & Gossett "Circuit Setter Plus"



F. Balancing valves in ferrous piping over 2 size shall have flanged or grooved ends and steel or cast iron construction. Option to balancing valves noted above are flow sensor specified in Section 230900 with a specified throttling valve.

1. Quarter-Turn Ball Valve Style (Ferrous Piping Greater Than 2"):

a. Manufacturers:

1) B&G "Circuit Setter"

G. Balancing valves in ferrous piping over 2" size shall consist of flow sensors as specified in Section 230900 combined with specified throttling valves.

H. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

## **2.7 AUTOMATIC FLOW CONTROL VALVES (AUTOMATIC BALANCING VALVES)**

A. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within  $\pm 10\%$  of the specified GPM over at least 95 percent of the control range.

B. Pump Head Requirements: The permanent pressure loss added to the pump head shall not exceed 7 feet.

C. Each valve shall have two P/T ports.

D. Five-year product warranty and first year cartridge exchange, up to 10 percent.

E. The internal wear surfaces of the valve cartridge shall be stainless steel or polyphenylsulfone orifice with an elastomeric diaphragm.

F. The internal flow cartridge shall be permanently marked with the GPM and spring range.

G. Valve body shall be brass on all valves 2" and under and ductile iron on all valves 2-1/2" and larger.

H. All valves shall be factory leak tested at 100 psi air under water.

I. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2" diaphragm gauge equipped with 10 foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.

J. Manufacturers:

1. Griswold
2. Autoflow
3. Versa Flow
4. Nexus
5. B&G
6. Victaulic
7. Hays Fluid Controls

- K. Complete integral piping package, which integrates shutoff valves, automatic flow control valves, vents, strainers and drains, is acceptable.

## 2.8 VENTURI FLOW MEASUREMENT

- A. Static Low loss Venturi: Flanged or grooved end, 400 psig at 250 deg F working pressure; ANSI 150 pressure class; carbon steel body and insert; P/T ports for external gauge connection;  $\pm 3\%$  accuracy. Size venturi to match pipe (not pump outlet) size, but reduce size by not more than one (1) if needed to provide a minimum of 20" w.c. differential pressure across the flow measuring taps at scheduled design flow rate. In no instance shall pressure drop exceed 60" w.c. at scheduled design flow rate.
- B. Manufacturers:
  1. IMI Flow Design
  2. Hayes Fluid Controls
  3. Tunstall/Macon
  4. Bell and Gossett

## 2.9 COMBINATION PIPING PACKAGES

- A. Combination piping packages are allowed at unitary equipment only (1" pipe size and smaller) in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined. Coil connections shall be rigid. Combination piping packages shall include:
  1. Shutoff valves
  2. Wye strainers, with 1/4 turn strainer blowdown valves with hose thread and cap
  3. Manual balancing valves with memory stop. Automatic flow control devices are allowed.
  4. Test plugs
  5. Manual air vents
  6. Unions
- B. Manufacturers:
  1. FDI Flowset
  2. Griswold
  3. Hays Fluid Controls
  4. HCI Terminator
  5. Nexus Coil Pak
  6. NIBCO, Victaulic

## 2.10 EXPANSION TANK

- A. Bladder Type:
  1. Tank shall be welded steel, ASME construction and stamped.
  2. Tank shall be complete with heavy-duty replaceable butyl bladder, charging valve, lifting ring, drain tapping, and system connection.
  3. 125 psig working pressure and 240°F maximum operating temperature.
  4. Manufacturers:
    - a. Thrush

- b. Taco
- c. Bell & Gossett
- d. Armstrong
- e. Watts
- f. Wessels
- g. Wheatley
- h. Amtrol
- i. Patterson
- j. Grundfos

## **2.11 TANGENTIAL AIR SEPARATORS**

- A. Separators shall be ASME constructed and stamped for 125 psi working pressure and 350°F operating temperature.
- B. Provide openings for inlet, outlet, blowdown, and expansion tank.
- C. Separators shall be line size or larger, with maximum pressure drop of 1 psi. Refer to drawing for separator sizing.
- D. Separators shall not include strainers, unless noted on the drawings. When furnished, strainers shall be removable and the blowdown fittings shall have drain valves.
- E. Manufacturers:
  - 1. Amtrol
  - 2. Armstrong
  - 3. Bell & Gossett
  - 4. Taco
  - 5. Wheatley
  - 6. Patterson
  - 7. Wessels
  - 8. Grundfos

## **2.12 DRAIN VALVES AND BLOWDOWN VALVES**

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

## **2.13 CONNECTIONS BETWEEN DISSIMILAR METALS**

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel, and stainless steel are commonly used and require isolation from each other with the following exceptions:
  - 1. Iron and steel connected to each other.
  - 2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Valves/Fittings and Accessories:
1. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.
  2. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.
  3. Prepare accessories for finish painting.
  4. Install accessories with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
  5. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

END OF SECTION 232116

**SECTION 232123 - HVAC PUMPS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. All pumps except where integral with a manufactured piece of equipment.
- B. Pump controls where self-contained.

**1.2 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Submit motor data indicating compliance with Section 230513.

**PART 2 - PRODUCTS****2.1 PUMPS - GENERAL**

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Heating pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 230513.
- G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.
- H. Pumps specified in this section operating in clean water with a flow greater than 25 GPM and less than 459 feet head shall have a maximum Pump Energy Index (PEI) as scheduled on the drawings. In no case shall the PEI exceed 1.0.

**2.2 IN-LINE PUMP**

- A. Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for horizontal or vertical operation.
- B. Casing: Cast iron, rated for greater of 125 psi or 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Impeller: Bronze or stainless steel, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.

- D. Shaft: Steel or stainless steel.
- E. Seals: Mechanical type with internal flushing rated for -20 to 225°F and comprised of Buna elastomer, carbon primary ring, and ceramic stationary ring.
- F. Seals: Mechanical type rated for -20 to 250°F with EPR or EPT bellows and seat gasket, carbon primary ring, and silicon-carbide stationary ring.
- G. Manufacturers:
  - 1. Bell & Gossett
  - 2. Taco
  - 3. Armstrong
  - 4. Grundfos/Peerless/PACO

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General Installation Requirements:
  - 1. Install all products per manufacturer's recommendations.
  - 2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18" clearance for removal of suction diffuser.
  - 3. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
  - 4. Install on vibration isolators as scheduled on drawings.
- B. In-Line Pumps:
  - 1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
  - 2. Pump orientation shall be in accordance with the manufacturer's recommendations.

END OF SECTION 232123

**SECTION 232500 - CHEMICAL (WATER) TREATMENT****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Treatment for Closed Systems (Water).
- B. Chemical Feed Equipment.

**1.2 REFERENCES**

- A. ASTM D 859-00: Test Method for Silica in Water
- B. ASTM D 1067-92: Test Methods for Acidity or Alkalinity in Water
- C. ASTM D 1068-03: Test Methods for Iron in Water
- D. ASTM D 1126-02: Test Method for Hardness in Water
- E. ASTM D 1129-03a: Terminology Relating to Water
- F. ASTM D 3370-95a: Practices for Sampling Water from Closed Conduits
- G. AWWA C700-02: Cold-Water Meters - Displacement Type

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Include system schematics, equipment locations, and controls schematics.
- C. Submit product data indicating chemicals and equipment.
- D. Submit manufacturer's installation instructions.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit reports indicating start-up of treatment systems is completed and operating properly. Include reports indicating analysis of system water after cleaning and after treatment.

**1.4 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include data on pumps and other equipment including spare parts lists, procedures, and treatment programs.
- C. Include step-by-step instructions on test procedures including target concentrations and test frequencies.
- D. Include list of treatment chemicals and associated SDS.

**1.5 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.

**1.6 REGULATORY REQUIREMENTS**

- A. Conform to all applicable codes and regulations for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Provide only chemicals approved for use and disposal by local authorities. Contact the Architect/Engineer if any specified chemicals are prohibited.

**1.7 MAINTENANCE SERVICE**

- A. Provide the following services to assist the owner in setting up and maintaining chemical treatment systems for one year from Date of Substantial Completion:
  - 1. Provide technical service visits to perform field inspections and make water analysis on site. Visits shall be twice annually for closed systems and monthly for steam and cooling tower systems. For cooling tower systems, monthly testing shall have dipslide culture counts, and quarterly water samples shall be sent to a CDC Elite lab for culturing to establish baseline total organism and Legionella counts. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit copies of the field service report after each visit to the Owner and to the Mechanical Contractor. Any problems related to the operation of the chemical treatment program shall be reported to the Architect/Engineer.
  - 2. Provide laboratory and technical assistance services for warranty period.
  - 3. Include 2 hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start-up of systems.
  - 4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.
  - 5. Provide sufficient chemicals for treatment and testing during warranty period.
- B. The Chemical Treatment Subcontractor shall be responsible for assisting the Mechanical Contractor by adding the chemical solutions required for cleaning each piping system. During the remainder of the warranty period, the Owner will be responsible for adding chemicals and doing other work related to the operation of system such as boiler blowdown. The Chemical Treatment Contractor shall make periodic tests of the chemical treatment program as called for above and recommend changes to Owner when needed.

**1.8 WATER ANALYSIS**

- A. Sample feedwater to determine appropriate chemical treatment. Contact the Architect/Engineer if test indicates treatment required is different than that specified.



## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT**

- A. Bypass (Pot) Feeder: 2.0 gal; quick-opening cap with 3-1/2" minimum diameter opening and opening wrench, legs to raise fill cap to 30" to 36", drain valve, air cock, working pressure of 200 psig at 200°F, 20 to 25-micron cartridge or bag filter.
  - 1. Acceptable Manufacturers:
    - a. Griswold
    - b. Vector Industries
    - c. J.L. Wingert
    - d. Neptune
- B. Automatic Boiler Blowdown Controller: 100-6000 microhm range, fixed or adjustable sample frequency, adjustable sample time, high and low limit alarms, 120V power requirement, nickel electrode probe, test switch, automatic blowdown valve and throttling valve.
- C. Multi-Function Controllers: Electronic controllers that perform several functions such as boiler bleed-off and chemical feed are acceptable.

### **2.2 TEST EQUIPMENT FOR LARGE PROJECTS ONLY**

- A. Provide white enamel test cabinet with light, capable of accommodating four 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the following test kits:
  - 1. Alkalinity titration test kit.
  - 2. Chloride titration test kit.
  - 3. Sulfite titration test kit.
  - 4. Total hardness titration test kit.
  - 5. pH test kit.
  - 6. Portable electronic conductivity meter with 0-10, 0-100, 0-1,000 and 0-10,000 microhm scales.
  - 7. High nitrite test kit.
  - 8. Chlorine test kit.
  - 9. Kits to test residuals of all chemicals added to all systems.
  - 10. Test kit for microbiological population and biocide effectiveness.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install bypass (pot) feeder with top approximately 36" above the floor.
- C. Coordinate with Contractor to provide temporary metering capabilities during system fill to determine overall system volume. Notify Architect/Engineer of overall system volume so that expansion tank sizing can be confirmed.

### 3.2 CLOSED-LOOP HYDRONIC SYSTEM WATER QUALITY STANDARDS

- A. Review equipment manufacturer's water quality standard to ensure water quality is sufficient to meet their warranty requirements as well as to ensure peak heat transfer efficiency. Contractor shall maintain hydronic systems within the more stringent of either the equipment manufacturer's requirements or those listed below:

Measured Value	Multi-Metal Systems with Aluminum	Multi-Metal Systems with Stainless Steel	Multi-Metal Systems with Copper
pH Range	8.5	8.5	9.0
Alkalinity as CaCO <sub>3</sub>	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Hardness as CaCO <sub>3</sub> *	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Suspended Solids	less than 10 mg/l	less than 10 mg/l	less than 10 mg/l
<b>Dissolved Solids</b>	less than 1,000 mg/l	less than 1,000 mg/l	less than 1,000 mg/l
Chlorides	less than 150 mg/l	less than 150 mg/l	less than 150 mg/l
<b>Iron</b>	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Manganese	less than 0.4 mg/l	less than 0.4 mg/l	less than 0.4 mg/l
Nitrate	less than 100 mg/l	less than 100 mg/l	less than 100 mg/l
<b>Sulfate</b>	less than 200 mg/l	less than 200 mg/l	less than 200 mg/l
Ammonia	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Free Copper	less than 0.10 mg/l	less than 0.10 mg/l	less than 0.10 mg/l

- B. Submit an independent third-party test report for each chemically treated closed-loop system showing compliance with all measured values shown in the above table as part of project closeout documentation.

END OF SECTION 232500

**SECTION 232533 - HVAC WATER FILTRATION EQUIPMENT****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Housings for bag type filters.
- B. Factory assembled, skid-mounted sand filter.
- C. Factory assembled, skid-mounted disc filter.

**1.2 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM on which the pump curves are based shall have impellers trimmed to deliver GPM and head scheduled.
- D. Submit motor data indicating compliance with Section 230513.

**1.3 EXTRA STOCK**

- A. Provide clean filters in all units in accordance with Part 3 requirements of this section.
- B. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

**PART 2 - PRODUCTS****2.1 BAG TYPE HOUSINGS/FILTERS**

- A. Provide bag filter housings meeting the following requirements:
  - 1. Housing Material: Carbon steel. Carbon steel housings shall have electro-polished interior surfaces and all exterior surfaces shall be factory finished with epoxy.
  - 2. Operating Pressure: 150 psi ASME code stamped.
  - 3. Pipe Connections:
    - a. Provide side-top inlet and side outlet connections.
  - 4. Seal Material: Solid Teflon VitonO-rings.
  - 5. Filter Basket: Type 304 stainless steel perforated filter bag basket.
  - 6. Housing/Filter Sizes: Provide filter housings as shown on flow diagrams as follows:
    - a. Nominal 4" diameter, 6" length suitable for use with Size 3 bag filters. Provide with 2" inlet and outlet connections.
    - b. Nominal 4" diameter, 12" length suitable for use with Size 4 bag filters. Provide with 2" threaded inlet and outlet connections.

- c. Nominal 6" diameter, 18" length suitable for use with Size 8 bag filters. Provide with 3/4"2"threaded inlet and outlet connections.
  - d. Nominal 6" diameter, 30" length suitable for use with Size 9 bag filters. Provide with 2"threaded inlet and outlet connections.
  - e. Nominal 8" diameter, 15" length suitable for use with Size 1 bag filters. Provide with 2"threaded inlet and outlet connections.
  - f. Nominal 8" diameter, 30" length suitable for use with Size 2 bag filters. Provide with 2"threaded inlet and outlet connections.
- B. Provide filter housings with the following options:
- 1. Tripod type adjustable carbon steel support legs for mounting filter housing on floor.
  - 2. Differential pressure ports on side of filter housing for measuring pressure drop across filter.
  - 3. Liquid displacer for easier replacement of filter bags.
- C. Provide multiple sets of polyesterpolypropylene felt bag filters with nominal 50 micron rating for each filter housing in accordance with Part 1 and Part 3 requirements of this section.
- D. Acceptable Manufacturers:
- 1. Eaton
  - 2. LeSac
  - 3. Pentair
  - 4. Rosedale

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install products per manufacturer's installation, operating, and maintenance instructions. Provide adequate clearance around equipment as required for maintenance and servicing.
- B. Provide 4" thick concrete housekeeping pad for all floor-mounted equipment with pads extending minimum 3" beyond all sides of equipment.

### **3.2 HOUSINGS FOR BAG TYPE FILTERS**

- A. Perform chemical cleaning and flushing of piping system in accordance with Section 232100 without bag filters installed in housings.
- B. After chemical cleaning, flushing, and draining operations are complete, provide clean bag filters in all housings. Fill hydronic systems with chemicals meeting Section 232500 requirements.
- C. Continuously circulate fluid through hydronic loops using system pumps for minimum 96 hours prior to hydronic systems balancing, changing bag filters when differential pressure across filter media exceeds 10 psi above the initial (new) filter media pressure drop.

- D. Final testing, adjusting, and balancing of hydronic systems shall be performed with bag filters installed in all housings.
- E. Provide one additional set of replacement bag filters for all housings in addition to the sets required for hydronic pipe systems cleaning in accordance with Part 1 of this section.

END OF SECTION 232533

**SECTION 233100 - DUCTWORK****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Galvanized Ductwork
- B. Ductwork Reinforcement
- C. Ductwork Sealants
- D. Rectangular Ductwork
- E. Round and Flat Oval Ductwork
- F. Exposed Ductwork (Rectangular, Round, or Oval)
- G. Flexible Duct
- H. Leakage Testing
- I. Ductwork Penetrations

**1.2 REFERENCES: Conform to all applicable requirements of the following publications:**

- A. ADC Flexible Duct Performance and Installation Standards, 3<sup>rd</sup> Edition 1996.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASHRAE - Handbook 2012 Systems and Equipment; Chapter 19 - Duct Construction.
- D. ASHRAE - Handbook 2013 Fundamentals; Chapter 21 - Duct Design.
- E. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.
- F. ASTM A90 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- G. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- H. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- I. ASTM E413-87 - Classification for Rating Sound Insulation.
- J. IECC - International Energy Conservation Code (latest published edition)
- K. NADCA Standard 05 1997 - Requirements for the Installation of Service Openings in HVAC Systems.

- L. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- M. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.
- N. SMACNA - Air Duct Leakage Test Manual.
- O. SMACNA - HVAC Duct Construction Standards.
- P. SMACNA - Round Industrial Duct Construction Standards - 1999 Edition.
- Q. UL 181 - Factory-Made Air Ducts and Air Connectors.

### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 230500.
- B. Submit duct fabrication standards in compliance with SMACNA and these specifications. Clearly indicate metal gauges, reinforcement, and joining methods intended for use for each pressure classification. Furnish details of all common duct fittings and joint connections to be used on this project.
- C. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.
- D. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
  1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
  2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
  3. Room names and numbers, ceiling types, and ceiling heights.
  4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
  5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 230500.
- E. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

### 1.4 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

- C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.
- D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

## 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 230500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
  1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
  2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
  3. Location and size of all duct access doors.
  4. Room names and numbers, ceiling types, and ceiling heights.
  5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
  6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS AND SUPPORTS

- A. Rectangular Duct - Single Wall:
  1. General Requirements:
    - a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
    - b. Transitions shall not exceed the angles in Figure 4-7.
  2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
    - a. All ducts shall be cross-broken or beaded.
    - b. Snap lock seams are not permitted.



- c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
- 1) Type 1:
    - a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
    - b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.
  - 2) Type 2:
    - a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
    - b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
  - 3) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
  - 4) Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
  - 5) Omitting every other vane is prohibited.
- d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA  $r/W=0.1$ ). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
- e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
- f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
- g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
- h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
- i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
- j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.

- k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

- 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
- 2) Manufacturers:
  - a) Ductmate Industries - 25/35/45
  - b) Nexus
  - c) Mez
  - d) WDCI
  - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

- l. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.

- 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
- 2) Flanges shall be 24-gauge minimum (not 26 gauge).
- 3) Manufacturers:
  - a) Lockformer TDC
  - b) TDF
  - c) United McGill
  - d) Sheet Metal Connectors
  - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Rectangular Duct - Double Wall:

1. All applicable portions of Rectangular Duct - Single Wall shall apply.
2. Furnish and install double-wall insulated airtight duct as shown on the drawings.
3. Duct Construction:
  - a. Rectangular double wall duct shall be suitable for pressures listed in the ductwork application schedule.
  - b. All ductwork gauges and reinforcement shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space-consuming reinforcement.
  - c. Ducts shall be 2" thick and completely metal enclosed with annular space completely filled with 1-1/2# density glass fiber insulation. Insulation shall have flame spread/smoke developed ratings of less than 25/50 per ASTM E84, NFPA 255, or UL 723.
  - d. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:
    - 1) Airtight, continuous welds at intersection of fitting body and tap.
    - 2) Tap liner spot welded to inner liner with weld spacing not over 3".
    - 3) Insulation packed around the tap area for complete cavity filling.

- 4) Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.
- e. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
- f. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
- g. Formed-on flanged transverse joint systems are acceptable if they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
  - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
  - 2) Flanges shall be 24-gauge minimum (not 26 gauge).
  - 3) Manufacturers, Formed-on Flanged Joint Systems:
    - a) Lockformer TDC
    - b) TDF
    - c) United McGill
    - d) Sheet Metal Connectors
    - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

C. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.

D. Round Snap-Lock Seam Ductwork - Single Wall:

1. Factory sealed snap-lock pipe. Transverse and longitudinal seams shall contain factory-applied self-sealing EPDM and co-polymer gasket. Snap-lock shall conform to SMACNA RL-8. Duct and gasket material shall meet the flame/smoke spread rating of 25/50 per ASTM-E84.
2. G-60 galvanized coating meeting ASTM A653 and ASTM A90 G-90 galvanized steel aluminum meeting ASTM B209 Alloy 3003 Temper H14 304 stainless steel meeting ASTM A480 2B Finish.
3. Snap-lock seams are only permitted on systems between -1"w.c. and 2"w.c. pressure class.
4. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
5. Duct and fittings shall meet the required minimum gauges listed in Chapter 3 of the SMACNA requirements for the specified pressure class.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Manufacturers:
  - a. GreenSeam Industries.

E. Hangers and Supports General Requirements:

1. Hanger and support materials shall be as defined within Materials and Application Specific section below.
2. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge attached to the bottom of ducts.
3. Cable Hangers:
  - a. Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork.
4. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs. Install per manufacturer's ratings and instructions.

## 2.2 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:

1. General Requirements:
  - a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
  - b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
  - c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
  - d. Ductwork reinforcement shall be of galvanized steel.

2. Duct Hangers and Support Material:
    - a. Ductwork hangers and supports shall be of galvanized or painted steel.
    - b. All fasteners shall be galvanized or cadmium plated.
- B. Exposed Ductwork (Rectangular, Round, and Flat Oval):
1. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:
    - a. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.
    - b. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.
    - c. Remove all identification stickers and thoroughly clean exterior of all ducts.
    - d. Locate fitting seams on least visible side of duct.
    - e. Provide exterior finish suitable for field painting without further oil removal.
    - f. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2" from the end of the duct.
    - g. Manufacturers, Slide-on Flanges:
      - 1) Ductmate Industries
      - 2) Accuflange
      - 3) Sheet Metal Connectors
    - h. Manufacturers, Self-Sealing Duct System:
      - 1) Lindab
      - 2) Ward "Keating Koupling"
    - i. The system shall be free of visible dents and scratches when viewed from normal occupancy.
    - j. All insulation shall be internal, except at reheat coils.
  2. In addition to the paragraphs above, this section applies to all ductwork specified or shown as "Architecturally Exposed":
    - a. All spiral ductwork fittings shall be carbon arc welded.
    - b. Grind all welds to remove irregularities.
    - c. Conical taps shall be one piece. Taps for grilles and takeoffs shall be factory installed with a continuous weld and ground smooth.
    - d. Welds shall be ground smooth and painted.
    - e. All architecturally exposed ducts shall be round or flat oval except where not possible (grilles, reheat coils, etc.).
  3. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:
    - a. Metal gauge of duct and fittings.
    - b. Fitting type and construction.
    - c. Type and size of reinforcement.

4. Hangers for Exposed Ductwork:
  - a. Round Ducts:
    - 1) Threaded rod with duct fixing bracket and metal strap. Provide single threaded rod centered on the duct. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel wrapping the circumference of the duct. Spacing as required by SMACNA guidelines.
    - 2) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Spacing and cable size as required by SMACNA guidelines.
      - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.
    - 3) Aircraft cable with 2-point support in standard horseshoe arrangement.
  - b. Rectangular Ducts:
    - 1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" in maximum dimension. Corner saddles are required when supporting rectangular ductwork. Spacing and cable size as required by SMACNA guidelines.
      - a) Manufacturers, Supports: Gripple, Ductmate, Duro Dyne, Architect/Engineer approved.
    - 2) Aircraft cable with 2-point support in standard horseshoe arrangement. Corner saddles are required when supporting rectangular ductwork.
  - c. Strut-channel and all-thread rod is not acceptable for exposed ductwork.
  - d. All fasteners shall be galvanized or cadmium plated.

### 2.3 DUCTWORK REINFORCEMENT

- A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
  1. Ducts must be over 18" wide.
  2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
  3. Tie rods must not exceed 1/2" diameter.
  4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

### 2.4 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000-hour minimum UV resistance per ASTM G-53.

- B. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20°F to +250°F.
- C. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F.
  - 1. Manufacturers, Pressure-Sensitive Tape:
    - a. Venture Tape 1581A
    - b. Compac #340
    - c. Scotch Foil Tape 3326
    - d. Polyken 339

## 2.5 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.
- E. Standard:
  - 1. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
  - 2. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft<sup>2</sup>\*°F\*hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm. "R" value shall not be less than 4.0 ft<sup>2</sup>\*°F\*hr/Btuh. Ducts in unconditioned spaces and ventilated attics: "R" value shall not be less than 6.0 ft<sup>2</sup>\*°F\*hr/Btuh.
  - 3. Usage:
    - a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
    - b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.

## F. Acoustic:

1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
2. Flexible have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft<sup>2</sup>\*F\*hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm. "R" value shall not be less than 4.0 ft<sup>2</sup>\*F\*hr/Btuh. Ducts in unconditioned spaces and ventilated attics: "R" value shall not be less than 6.0 ft<sup>2</sup>\*F\*hr/Btuh.
4. Minimum Acoustic Insertion Losses per octave band:

## a. Straight Duct:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	4.0	13	15	15	16	17	16
6" ø	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" ø	6 ft	5.7	14	13	15	16	18	16
8" ø	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" ø	6 ft	5.5	13	12	15	15	18	13
12" ø	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

## b. 90deg Elbow:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	10	15	16	17	18	17	18
6" ø	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" ø	6 ft	10	15	16	17	16	18	18
8" ø	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" ø	6 ft	11	14	15	16	15	16	15
12" ø	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

## 5. Usage:

- a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
- b. Connections to air inlets and outlets. Do not exceed 5'-0" in length.
- c. Acceptable Manufacturers:
  - 1) Flexmaster USA - Type 6
  - 2) Thermaflex M-Ke

## G. Radius Forming Elbows:

1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
2. Usage: All supply air terminals with flexible ductwork connection.



3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturer's instructions.
4. Acceptable Manufacturers:
  - a. Hart & Cooley - Smartflow
  - b. Thermaflex - Flexflow
  - c. Titus - Flexright

## 2.6 ACOUSTICAL LAGGING

- A. Refer to drawings for acoustical lagging locations.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- F. Repair all duct insulation and liner tears.
- G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.
- I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- K. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- L. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, where applicable.

- M. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- N. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

### 3.2 DUCTWORK APPLICATION SCHEDULE

- A. Duct System Description: RTU #1 & RTU #2 Supply Duct from Fan to Terminal Air Boxes:
  - 1. Shape: a. Rectangular Duct- Single Wall / b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
  - 2. Material: Galvanized Steel
  - 3. Pressure Class: +4" + 0.75kPa
  - 4. Seal Class: A
  - 5. Insulation: 1-1/2" thick Type A (R=4.5)
  - 6. Additional Requirements: Provide all with slide on or formed on flanges
- B. Example #2 Duct System Description AHU-3 Supply Duct from Fan to Terminal Air Boxes:
  - 1. Shape: Rectangular Duct - Single Wall
  - 2. Material: Galvanized Steel.
  - 3. Pressure Class: +3"+0.75kPa
  - 4. Seal Class: A
  - 5. Insulation: 1-1/2"40 mm thick Type A (R=4.5)
  - 6. Additional Requirements: Provide all with slide-on or formed-on flanges
- C. General:
  - 1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
  - 2. Insulation:
    - a. Refer to Section 230713 for insulation types.
    - b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).
  - 3. Note 1: Apply aluminum based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.
  - 4. Note 2: Apply aluminum based adhesive sealant tape on TAB boxes (all seams and joints of the box and duct connections) serving dedicated outside air supply (DOAS) system.
- D. Exterior Supply Duct from Fan to Terminal Air Boxes - Double Wall:
  - 1. Shape:
    - a. Rectangular Duct - Double Wall
    - b. Round and Flat Oval Spiral Seam Ductwork - Double Wall
  - 2. Material: Galvanized Steel
  - 3. Pressure Class: +3"
  - 4. Seal Class: A

5. Insulation:
    - a. ASHRAE 90.1-2019: 2" thick Type E (R=7.4)
    - b. IECC-2021: 2" thick Type E (R=7.4)
  6. Additional Requirements: None
- E. Supply Duct from Terminal Air Boxes to Outlets:
1. Shape:
    - a. Rectangular Duct - Single Wall
    - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
    - c. Round Snap-Lock Seam Ductwork - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +2"
  4. Seal Class: A
  5. Insulation:
    - a. ASHRAE 90.1-2019: 1-1/2" thick Type A (R=4.5)
    - b. IECC-2021: 1-1/2" thick Type A (R=4.5)
  6. Additional Requirements: None
- F. Return Duct:
1. Shape:
    - a. Rectangular Duct - Single Wall
    - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: -2"
  4. Seal Class: A
  5. Insulation:
    - a. ASHRAE 90.1-2019: None
    - b. IECC-2021: None
  6. Additional Requirements: None
- G. General Exhaust Duct:
1. Shape:
    - a. Rectangular Duct - Single Wall
    - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: -1"
  4. Seal Class: A
  5. Additional Requirements: None

## H. Combustion Air Duct:

1. Shape:
  - a. Rectangular Duct - Single Wall
  - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1"
4. Seal Class: A
5. ASHRAE 90.1-2019 and IECC-2021
  - a. Insulation: 1 1/2" thick Type B (R=6.0)
6. Additional Requirements: None

## I. Transfer Ducts:

1. Shape:
  - a. Rectangular Duct - Single Wall
  - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: -1/2"
4. Seal Class: A
5. Insulation: 1" thick Type C (R=3.6)

## J. General Exhaust Duct:

1. Shape: Rectangular Duct
2. Material: Phenolic Non-Fibrous Closed Cell Ductwork - Indoor
3. Pressure Class: -3"
4. Seal Class: A
5. Insulation: None

## K. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):

1. Insulation:
  - a. ASHRAE 90.1-2019: 1-1/2" thick Type A (R=4.5)
  - b. IECC-2021: 1-1/2" thick Type A (R=4.5)

## L. All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers:

1. Insulation: 1-1/2" thick Type A (R=4.5)

## M. Linear Diffuser Supply Plenum:

1. Insulation:
  - a. ASHRAE 90.1-2019: 1/2" thick Type C (R=1.8)
  - b. IECC-2021: 1/2" thick Type C (R=1.8)

### 3.3 DUCTWORK SEALING

- A. General Requirements:
1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
  2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
  3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
  4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.
- B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.
- C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

### 3.4 TESTING

- A. Interior Duct - Less than 3" WG (positive or negative):
1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
  2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
  3. Seal ducts to bring the air leakage into compliance.
  4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- B. Exterior Duct - 1/2" WG and Above (positive or negative):
1. All exterior ductwork (outside the building envelope) shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
  2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
  3. Seal ducts to bring the air leakage into compliance.
  4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
  - a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
  - b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
  - c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
  - d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
  - e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
  - f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
  - g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
  - h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
  - i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

### 3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

END OF SECTION 233100

**SECTION 233300 - DUCTWORK ACCESSORIES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Manual Volume Dampers.
- B. Backdraft Dampers.
- C. Fabric Connectors.
- D. Drip Pans.
- E. Duct Access Doors.

**1.2 REFERENCES**

- A. ASTM E477-06a - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- B. ASTM E2336-04 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.
- C. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- D. SMACNA - HVAC Duct Construction Standards (latest edition).

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit manufacturer's installation instructions.

**PART 2 - PRODUCTS****2.1 MANUAL VOLUME DAMPERS**

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

## 2.2 BACKDRAFT DAMPERS

- A. Gravity backdraft dampers, size 18 inches x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.
- B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90° stop, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
- C. Models:
  1. Ruskin CBD4
  2. Arrow 655
  3. Safe-Air/Dowco BRL
  4. Greenheck EM.

## 2.3 FABRIC CONNECTORS

- A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
- B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.
- C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.
- D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
- E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
- F. Fabric connectors shall not be painted.
- G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.
- H. Materials:
  1. Durodyne MFN-4-100
  2. Vent Fabrics, Inc.
  3. "Ventglas"
  4. Proflex PFC3NGA
- I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.



J. Materials:

1. Durodyne "Duralon MFD-4-100"
2. Vent Fabrics, Inc.
3. "Ventlon"
4. Proflex PFC3HGA

## 2.4 DRIP PANS

- A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.
- B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.
- C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.
- D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

## 2.5 DUCT ACCESS DOORS

- A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.
- C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- D. Access doors with sheet metal screw fasteners are not acceptable.
- E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.
- F. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.
- G. Fire Damper, Fire/Smoke Damper Access Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. For ducts larger than 12x12, provide one access door. For ducts 12" x 12" and smaller, provide one access door on bottom and one on side.

## 2.6 DUCTWORK ACCESSORY SEALANTS

- A. Ductwork accessory sealants and adhesives shall conform to Section 233100.

**PART 3 - EXECUTION****3.1 INSTALLATION**

## A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Provide duct test holes where indicated and as required for testing and balancing purposes.

## B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

## C. Drain Pan:

1. Drain pans shall be installed per ASHRAE 62.1.
  - a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.
  - b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

END OF SECTION 233300

**SECTION 233423 - POWER VENTILATORS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Roof Exhaust Fan.
- B. Rooftop Exhaust Fan - Vertical Discharge - Belt Driven.
- C. Rooftop Fan Curbs.
- D. Room Exhaust Fan.

**1.2 QUALITY ASSURANCE**

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.
- D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

**1.3 REFERENCES**

- A. AMCA 99 - Standards Handbook.
- B. AMCA 208 - Calculation of the Fan Energy Index (FEI).
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 230 - AMCA 230 - Laboratory Methods of Testing Air Circulating Fans for Rating and Certification.
- E. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- G. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- H. ANSI/AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- I. SMACNA - HVAC Duct Construction Standards (latest edition).

**1.4 SUBMITTALS**

- A. Submit shop drawings per Section 230500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point (ceiling and HVLS fans are exempt from FEI submittal requirements).
- B. Submit manufacturer's installation instructions.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

**1.5 EXTRA STOCK**

- A. Provide one (1) extra belt set for each fan unit.

**PART 2 - PRODUCTS****2.1 ROOFTOP EXHAUST FAN - BELT DRIVEN**

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. Any steel parts shall be galvanized or epoxy coated. Non-corrosive fasteners.
- E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- F. Motor mounted outside of airstream and ventilated with outside air. Motor not less than 1/3 HP.
- G. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- H. Mill aluminum finish.
- I. Speed Controller: For single phase induction motor fans, furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- J. Bearings:
  - 1. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.
- K. Manufacturers:
  - 1. Aerovent "FACX"

2. Cook "ACE-B"
3. Greenheck "GB"
4. Carnes "VEB"
5. PennBarry DX
6. ACME PV
7. ILG CRB
8. Twin City BCRD
9. York

## 2.2 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum or composite with backward inclined or airfoil blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. Any steel parts shall be galvanized or epoxy coated. Non-corrosive fasteners.
- E. Direct drive, motor mounted outside of airstream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Mill aluminum finish.
- H. Speed Controller: For single phase induction motor fans, furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- I. Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
- J. Manufacturers:
  1. Aerovent "FACX"
  2. Cook "ACE-D"
  3. Greenheck
  4. ILG - CRD
  5. ACME PX
  6. PennBarry DX
  7. Carnes
  8. Twin City DCRU
  9. Jenco
  10. Soler-Palau
  11. York

## 2.3 ROOFTOP FAN CURBS

- A. Furnish and install prefabricated roof curbs for all rooftop fans.
- B. Size curb to match the curb cap of fan.
- C. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

- D. Construction: Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer. Curb.
  - 1. 18-gauge galvanized steel.
- E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.
- F. Manufacturers:
  - 1. Same manufacturer as the fan
  - 2. Pate
  - 3. RPS
  - 4. Thy

## 2.4 ROOM EXHAUST FAN

- A. Fiberglass lined sheet metal housing.
- B. Rubber torsion motor mounts.
- C. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for fractional horsepower induction motors, with thermal overload relay, toggle operator.
- D. Built-in backdraft damper.
- E. Centrifugal fan.
- F. Molded white plastic or aluminum ceiling grille.
- G. Provide variable speed controller if called for on the drawings.
- H. Manufacturers:
  - 1. ACME
  - 2. Broan
  - 3. Carnes
  - 4. Cook
  - 5. Jenco
  - 6. PennBarry
  - 7. Greenheck
  - 8. Panasonic
  - 9. Soler-Palau
  - 10. York

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Secure roof exhausters with cadmium plated lag screws to roof curb.
- C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.
- D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION 233423

**SECTION 233600 - AIR TERMINAL UNITS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Single Duct Variable Air Volume Terminal Box.
- B. Fan Powered Variable Air Volume Terminal Box.

**1.2 REFERENCES**

- A. NFPA 70 - National Electrical Code.
- B. NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- C. UL 181 - Factory-Made Air Ducts and Connectors.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
- C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.
- D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit manufacturer's installation instructions.

**1.4 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.
- C. Include directions for resetting constant volume regulators.

**PART 2 - PRODUCTS****2.1 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX**

- A. Casing: Minimum 22 gauge galvanized steel.



1. Insulation: Insulation shall be UL listed and meet NFPA 90A requirements. Fully insulated with:
  - a. 3/4" elastomeric closed cell insulation liner.
  - b. Usage: All supply air systems.
2. Non-insulated.
  - a. Usage: Return air system, exhaust air system.
- B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.
- C. Inlet Flow Sensor: Provide "cross" • or "ring" • style velocity and static sensor at inlet to box for use by unit controller.
- D. Damper Operators: Furnish all mounting brackets, relays, and linkages. Damper operator shall be provided as follows:
  1. Electronic: Provided by the manufacturer and installed in the factory. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- E. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016" wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.
- F. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.
- G. Refer to control diagrams and notes on control drawings for complete sequence of control.
- H. Manufacturers:
  1. Titus
  2. Krueger
  3. Carnes
  4. E.H. Price
  5. Tuttle & Bailey
  6. Nailor
  7. Enviro-Tec
  8. Johnson Controls Inc.
  9. Metalaire.
  10. Anemostat.

## 2.2 FAN POWERED VARIABLE AIR VOLUME TERMINAL BOX

- A. Casing: Parallel minimum 22 gauge galvanized steel. Factory mounted access panel to provide access to air valve and fan.

1. Insulation: Insulation shall be UL listed and meet NFPA 90A requirements. Fully insulated with:
    - a. 3/4" elastomeric closed cell insulation liner.
    - b. Usage: All supply air systems.
  2. Non-insulated.
    - a. Usage: Return air system, exhaust air system.
- B. Fan: FC style, galvanized steel fan wheel. Fan housing shall be 22 gauge steel and fan board shall be 18 gauge steel. Maximum motor temperature rise on all speeds of 50°F (10°C). Fan motor voltage shall be as scheduled on the drawings. Motors shall be permanently lubricated, direct drive.
1. .
- C. Damper Blades: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.
- D. Inlet Flow Sensor: Provide "cross" or "ring" style velocity and static sensor at inlet to box for use by unit controller.
- E. Damper Operators: Furnish all mounting brackets, relays, and linkages. Damper operator shall be provided as follows:
1. Electronic: Provided by the manufacturer and installed in the factory. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- F. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016" wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.
- G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.
- H. Refer to control diagrams and notes on control drawings for complete sequence of control.
- I. Manufacturers:
1. Carrier
  2. Titus
  3. Trane
  4. Krueger
  5. Carnes
  6. E.H. Price
  7. Nailor
  8. Enviro-Tec

9. Johnson Controls Inc.
10. Anemostat.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from adjacent ductwork.
- E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.
- F. Comb fins on coils to repair bent fins.
- G. Insulate terminal air box hydronic reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate or interfere with actuator, access panel and control panel.

#### **3.2 ADJUSTING**

- A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION 233600

**SECTION 233700 - AIR INLETS AND OUTLETS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Grilles And Registers.
- B. Linear Diffusers.
- C. Linear Diffuser Supply Plenum.
- D. Goosenecks.

**1.2 QUALITY ASSURANCE**

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

**1.3 REFERENCES**

- A. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.
- D. SMACNA - Duct Construction Standards.

**1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 230500.
- B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
- C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
- D. Submit manufacturer's installation instructions.

**1.5 REGULATORY REQUIREMENTS**

- A. Conform to ANSI/NFPA 90A.
- B. Conform to ASHRAE 90.1.

**1.6 EXTRA STOCK**

- A. Provide clean filters in all filter return grilles at time of installation.
- B. Provide one additional set of replacement filters for all filter return grilles. Deliver to Owner at job site.

**PART 2 - PRODUCTS****2.1 AIR TERMINALS - GRILLES AND REGISTERS**

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10<sup>-12</sup> watts with a 10 dB room effect. .
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Where specified to have filters, provide with filter rack suitable for 1" thick MERV-8 pleated media filters. Grille border shall be fabricated from minimum 22 gauge steel or minimum 0.040-inch thick for aluminum grilles. Provide removable grille face with metal knurled knob or quarter turn fastener to allow for filter media replacement.
- L. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- M. Manufacturers:
  - 1. Tuttle & Bailey
  - 2. Titus
  - 3. Price
  - 4. Nailor

5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

## 2.2 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect.
- F. Diffusers shall be architectural solid square panel and flush with ceiling.
- G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.
- H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).
- I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.
- J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)
- K. Manufacturers:
  1. Tuttle & Bailey
  2. Titus
  3. Price
  4. Nailor
  5. Carnes
  6. Metalaire
  7. Krueger
  8. Anemostat
  9. Raymon Donco

## 2.3 AIR TERMINALS - LINEAR DIFFUSERS

- A. Plenum Slot Diffusers (Lay-In):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
  2. The capacity and size of the unit shall be as shown on the drawings.
  3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect.
  4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
  5. Linear diffusers and mounting frames shall be furnished as one piece up to 5' in length.
  6. Diffusers shall be furnished with factory installed adjustable "ice tong" style pattern deflectors capable of providing 180° pattern adjustment.
  7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
  8. Number and width of slots shall be as shown on the drawings.
  9. Provide integral insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
  10. Manufacturers:
    - a. Tuttle & Bailey ITPS
    - b. Carnes DA
    - c. Price TBD
    - d. Krueger PTBS
    - e. Nailor 5800
    - f. Titus TBD
    - g. Metalaire
    - h. Anemostat API
    - i. Raymon Donco SAT
  11. Manufacturers for fire-rated diffusers:
    - a. Kees FRK-UL
    - b. Titus TBD-FR
    - c. Krueger PFTBS
    - d. Price TBD2-FR
    - e. Raymon Donco 2000FR
    - f. Metalaire
- B. Linear Slot Diffusers (Continuous):
1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
  2. The capacity and size of the unit shall be as shown on the drawings.
  3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect.
  4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
  5. Provide with concealed fasteners for installation in the field.
  6. Linear diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.

7. Diffusers shall be furnished with adjustable pattern deflectors capable of providing 180° pattern adjustment.
8. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
9. Number and width of slots shall be as shown on the drawings.
10. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
11. Manufacturers:
  - a. Tuttle & Bailey 6000/7000
  - b. Carnes CH
  - c. Price SDS
  - d. Krueger 1900
  - e. Nailor 5000
  - f. Titus ML
  - g. Anemostat SLAD
  - h. Raymon Donco HPL
  - i. Metalaire

C. Linear Slot Diffusers (High Performance):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10<sup>-12</sup> watts with a 10 dB room effect per ANSI/ASHRAE 70.
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Provide with concealed fasteners for installation in the field.
6. Linear slot diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.
7. Diffusers shall be furnished with adjustable pattern deflectors.
8. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
9. Number and width of slots shall be as shown on the drawings.
10. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
11. Manufacturers:
  - a. Price JS
  - b. Titus FL
  - c. Krueger DF
  - d. Anemostat FF
  - e. Raymon Donco WF2000
  - f. Metalaire



## 2.4 AIR TERMINALS - LINEAR DIFFUSER SUPPLY PLENUM

- A. Linear diffusers shall be provided with field fabricated or prefabricated supply plenums. Plenum shall be a minimum of 2-1/2" wider than total slot width, minimum length of slot, and minimum height of 10". Plenums with end fed duct connections shall not exceed 8' in length. The cross sectional area of the plenum shall be designed for a maximum velocity of 500 fpm and the aspect ratio shall be limited to a width-to-height ratio of less than 1.5. Plenums with side outlets shall be designed for a maximum velocity of 600 fpm and inlet ducts to plenum shall be spaced 5' on center maximum. Inlet ducts to plenums shall have a maximum velocity of 900 fpm. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
- B. Plenum shall be constructed with 24 gauge galvanized steel and shall have side inlets unless shown otherwise on the drawings. Refer to Ductwork Application Schedule in Section 233100 for insulation requirements.
- C. End caps and required accessories shall be integral with the plenum or furnished and installed by the Mechanical Contractor.
- D. A manual volume damper shall be furnished and installed by the Mechanical Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
- E. Prefabricated plenums shall be by the same manufacturer as the linear diffuser or Kees Inc.

## 2.5 GOOSENECKS

- A. Fabricate in accordance with SMACNA Duct Construction Standards of minimum 18 gauge galvanized steel.
- B. Mount on minimum 12 inch high curb base.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General Installation Requirements:
  1. Install items in accordance with manufacturers' instructions.
  2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
  3. Install diffusers to ductwork with air tight connections.
  4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
  5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.
- B. Volume Damper:
  1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 230500.

END OF SECTION 233700

**SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Breechings.
- B. Gas Vents.

**1.2 REFERENCES**

- A. ANSI Z181.1 (UL 959) - Medium Heat Appliance Factory Built Chimneys.
- B. ANSI Z21.66 - Electrically Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
- C. ANSI Z223.1 (NFPA 54) - The National Fuel Gas Code.
- D. ANSI/ASTM C64 - Refractories for Incinerators and Boilers.
- E. ANSI/UL 103 - Standard for Factory Built Chimneys for Residential Type and Building Heating Appliances.
- F. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- G. UL 441 - Standard for Gas Vents.
- H. UL 641 - Standard for Type L Low-Temperature Venting Systems.

**1.3 SUBMITTALS**

- A. Submit shop drawings per Section 230500. Include general construction, dimensions, weights, support and layout of breechings. Where factory built units are used submit layout drawings indicating plan view and elevations.
- B. Submit product data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights.
- C. Submit engineering report and manufacturer's certificate that refractory lined metal stacks meet specified requirements.
- D. Submit manufacturer's installation instructions.

**1.4 DEFINITIONS**

- A. Breeching or Vent Connector: Conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Combustion Air: Air that is supplied to combustion appliances to be used in the combustion of fuels and the process of venting combustion gases.

- D. Smoke Pipe: Round, single wall vent connector.
- E. Vent: Conveys flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

## 1.5 DESIGN REQUIREMENTS

- A. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

## PART 2 - PRODUCTS

### 2.1 BREECHINGS

- A. Equipment with Power Burners or Induced Draft Fans:
  1. 10 gauge black steel. All welded construction including joints.
  2. Insulate with high temperature fiberglass insulation as specified in Section 230716.
  3. Provide high temperature gasket at all flanged connections to equipment.
- B. Equipment with Atmospheric Burners:
  1. 26 gauge galvanized lock seam ductwork.
  2. Secure all joints with at least three sheet metal screws or rivets.
  3. Make final connections to all equipment, draft hoods and vent stacks.
- C. Provide adjustable self-actuating barometric draft dampers where shown, full size of breeching.
- D. Provide cleanout doors of same gauge as breeching where shown on drawings.
- E. Reinforce rectangular breeching with angle frames and round breeching with flanged girth joints or angle frames. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- F. Fabricate breeching fittings to match adjoining breechings. Fabricate elbows with centerline radius equal to breeching diameter. Limit angular tapers to 20° maximum.

### 2.2 CLASS B GAS VENTS

- A. Galvanized steel outer pipe. Aluminum liner pipe. 0.25"insulating air space between pipes. Type B listed by UL.
- B. Inside diameter of the liner shall be as shown on the drawings.
- C. Extend up 2'-0" above the nearest obstruction within 20'-0" and terminate with a rain and bird proof cap.
- D. Install tall cone flashing and storm collar at roof.
- E. Maintain 1" clearance to all enclosures.
- F. Manufacturers:
  1. AMPCO
  2. DuraVent

3. Hart & Cooley
4. Heat Fab
5. Metal-Fab
6. Schebler
7. Selkirk/Metalbestos
8. Van-Packer.

### 2.3 POSITIVE PRESSURE GAS VENTS AND INTAKES (NON-CONDENSING)

- A. The venting system shall be ANSI/UL 103 listed for use in positive pressure applications. For use with equipment burning gas, liquid or solid fuels as described in NFPA 211, Section 2-3-.1 and Appendix A.
- B. The vent system shall be double wall metal with a minimum of 1" air space between the walls. Outer wall shall be aluminum coated steel 0.034" thick.
- C. The inner pipe shall be Type 316 stainless steel 0.035" thick in all sizes.
- D. Seal each inner pipe joint during field installation with RTV silicone sealant for flue gas temperatures up to 600°F. For gas temperatures over 600°F, seal the joints with #33 joint cement, rated for 125% of design temperature.
- E. The chimney termination must comply with local building codes or Appendix D, NFPA No. 211.
- F. Protect all exposed metal parts with at least one base coat and one finish coat of heat and corrosion resistant primer and exterior paint.
- G. Usage: Non-condensing boiler positive pressure gas vent.
- H. Install ventilated thimble at roof penetration.
- I. Manufacturers:
  1. AMPCO
  2. DuraVent
  3. Hart & Cooley
  4. Heat Fab
  5. Metal-Fab
  6. Schebler
  7. Security (M&G Group)
  8. Selkirk/Metalbestos
  9. Van-Packer.
- J. Polypropylene Piping:
  1. Vent flue pipe shall be Intertek / ETL listed to ULC-S636 Listed as a Class IIA, IIB, and IIC vent system with operating temperatures of up to 230°F. The closure system to be rated as gas tight for 5" w.c. positive pressure flue gas service.
  2. Pipe: Polypropylene; for use with ANSI Category II and IV gas-burning appliance.
  3. Joints: Polypropylene socket fused or electrofusion.
  4. Fittings: Same as pipe.
  5. Limitations: Shall not be used in a plenum unless listed in 25/50 per ASTM E84/UL723.
  6. Vent system is to be sized in accordance with manufacturer's recommendations and the current edition of NFPA 54/ANSI Z223.1: National Fuel Gas Code and ASHRAE recommendations.

7. Usage: Boiler combustion air intake only. Polypropylene shall not be permitted for use with non-condensing boiler venting.
8. Furnish roof flashing with concentric roof vent kit and cap.

## 2.4 POSITIVE PRESSURE GAS VENTS AND INTAKE (CONDENSING AND HIGH EFFICIENCY)

### A. Stainless Steel (AL29-4C):

1. The venting system shall be ANSI/UL 1738.
2. The venting system shall be double wall metal with a minimum of 1" air space between the walls. Outer wall shall be Type 430 stainless steel.
3. The inner pipe shall be AL29-4C.
4. Vent flue pipe shall be UL listed for Category III and IV appliances with operating temperatures of up to 480°F. The closure system to be rated as gas tight for 5" w.c. positive pressure flue gas service.
5. Fasteners to be same material as piping and shall maintain 1" air space between walls.
6. The joints shall be gas tight to prevent leakage of flue or condensate.
7. Vent system is to be sized in accordance with manufacturer's recommendations and the current edition of NFPA 54/ANSI Z223.1: National Fuel Gas Code and ASHRAE recommendations.
8. Furnish roof flashing with vent cap.
9. Usage: Condensing and high efficiency boiler positive pressure gas vent and combustion air intake.
10. Manufacturers:
  - a. AMPCO
  - b. DuraVent
  - c. Hart & Cooley
  - d. Heat Fab
  - e. Metal-Fab
  - f. Schebler
  - g. Selkirk/Metalbestos
  - h. Van-Packer

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Prior to putting boilers into operation, Contractor shall provide full penetration welds for the entire length of each pipe section for all inner and outer shell seams to prevent leakage of flue gases. Riveted, tack, or spot-welded seams are not permitted.
- B. Install all products in accordance with manufacturer's instructions.
- C. Install in accordance with recommendations of ASHRAE - Handbook, Chapter "Chimney, Gas Vent, and Fireplace Systems", NFPA 211, and ANSI Z223.1 (NFPA 54).
- D. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.

- E. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Guide vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for duct support configuration and size. Provide expansion compensation approved by the manufacturer.
- F. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- G. Install vent dampers near draft hood collars and secured to breechings.
- H. Level and plumb chimneys and stacks. Provide 3/4" condensate drain at base of all chimneys and stacks over 12" diameter. Pipe condensate to nearest floor drain.
- I. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- J. Provide slip joints permitting removal of appliances without removal or dismantling of breechings, chimneys, or stacks.

END OF SECTION 235100

**SECTION 235216 - CONDENSING BOILERS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Boilers.
- B. Controls and Boiler Trim.
- C. Hot Water Connections.
- D. Fuel Burning System and Connection.
- E. Vent Connection.
- F. Boiler Vent Flue.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with at least three years documented experience.
- B. Provide factory authorized start-up service by manufacturer's agent.
- C. Conform to ANSI/ASME SEC 4 and ANSI/AGA Z21.13 for construction of boilers.
- D. Boiler Units: AGA certified, UL listed and ASME certified.
- E. Installation shall meet the requirements of ASME CSD-1, including remote emergency shutdown switches for boilers, applicable gas train, individual venting of gas regulators, and repackable shutoff valves at all boilers.
- F. Conform to ASHRAE 90.1.

**1.3 REFERENCES**

- A. AGA - Directory of Certified Appliances and Accessories.
- B. ANSI/AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- C. ANSI/AGA Z223.1 - National Fuel Gas Code.
- D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ANSI/ASME SEC 4 - Boiler and Pressure Vessels Code - Rules for Construction of Heating Boilers.
- F. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.
- G. ANSI/NFPA 70 - National Electrical Code.



- H. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.
- I. NFPA 85 - Boiler and Combustion Systems Hazard Code.

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 230500.
- B. Submit product data indicating general assembly, components, controls, safety controls, and electrical power/controls wiring diagrams, and service connections.
- C. Submit manufacturer's installation instructions.
- D. Submit reports indicating condition and operation at start-up.
- E. Submit reports indicating specified performance and efficiency is met or exceeded.
  - 1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

#### **1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data. Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

### **PART 2 - PRODUCTS**

#### **2.1 BOILERS**

- A. Provide factory assembled, factory fire-tested, self-contained unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
- B. Unit: Hot water, condensing type boiler with integral forced draft or pulse combustion burner, burner controls, boiler trim, insulation and jacket.
- C. ASME allowable working pressure of 150 psig water.
- D. Provide two lifting eyes on top of boiler.
- E. Unit casing shall be a minimum of 16 gauge steel. Factory paint boiler, base, and other components with hard finish enamel.
- F. Porcelain enameled or stainless steel exhaust manifold with gravity drain and reservoir for condensate elimination.

## G. Single Fuel:

## 1. Manufacturers:

- a. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- b. Thermal Solutions (Apex)
- c. Thermal Solutions (Arctic)
- d. Raypak (Xfrye)
- e. Buderus/Bosch (SSB)
- f. RBI (Torus)
- g. RBI (Infinite Energy<sup>2</sup>)

## H. Single Fuel:

## 1. Manufacturers:

- a. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- b. Fulton (Endura)
- c. Aerco International, Inc. (Benchmark)
- d. Riverside Hydronics M3
- e. Cleaver Brooks (Clear Fire)
- f. Viessman (Vitocrossal)
- g. Lochinvar (Crest)
- h. Riello (RTC)
- i. RBI (Flexcore)

## I. Dual-Fuel:

## 1. Manufacturers:

- a. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- b. Fulton Vantage DF
- c. Riello RTC
- d. Buderus/Bosch (SSB Commercial)
- e. Aerco (MFC)

**2.2 HEAT EXCHANGER**

- A. Condensing type, constructed from stainless steel water tube design that is suitable for return water temperatures as low as 50°F.
- B. Seven-year prorated warranty against leakage due to thermal shock or corrosion.

**2.3 BOILER FLUE**

- A. The boiler manufacturer shall review and approve vent size, type, and routing of all vent flue piping, fittings, dampers, and accessories as required to properly vent the equipment. Vent piping shall be UL listed for use with category III and IV appliances with operating temperatures of up to 480°F.
- B. Refer to Section 235100 for materials.

**2.4 HOT WATER BOILER TRIM**

- A. Provide ASME safety relief valve set at 125 psi or boiler maximum allowable working pressure.
- B. Provide low water cut-off with manual reset to automatically prevent burner operation whenever boiler water falls below safe level.
- C. Provide operating temperature controller to control burner operation to maintain boiler water temperature, as determined by a remote 4-20 mA signal from building DDC system or boiler controller.
- D. Limit temperature controller to control burner to prevent boiler water temperature from exceeding safe system water temperature.
- E. Provide all trim required to meet ASME CSD-1. This includes, but is not limited to, gas train and all terminals and necessary relays for connection to remote shutdown switch(es) to disconnect all power to the burner controls.

**2.5 FUEL BURNING SYSTEM - SINGLE FUEL**

- A. General: Forced draft automatic burner integral with boiler designed to burn natural gas at 8.5" to 14" W.C. inlet pressure. Maintain fuel-air ratios automatically.
- B. Gas Burner: Forced draft, power burner with interrupted spark ignition and flame sensor.
- C. Include on unit complete gas train including gas safety shutoff valve conforming to CSD-1 requirements. Vent all gas valves to outdoors separately.
- D. Burner to be modulating with a minimum turndown ratio of 20:1.

**2.6 CONTROL PANEL**

- A. The boiler system control panel shall include contacts for a trouble alarm to the DDC system.
- B. Program relay to control ignition, starting and stopping of burner and provide both pre-combustion purge and post combustion purge. Burner to shut down in event of ignition or main flame failure. Interlock to shut down burner upon combustion air pressure drop.
- C. Manual-automatic selector switch to permit automatic firing in accordance with load demand, or manual control of firing rate at fixed temperature.
- D. Panel to include indicating lights to show fault conditions of low water level, flame failure, fuel pressure, exhaust temperature, water temperature, or combustion air pressure. Mount indicating lights and switches in hinged drop-panel for access to wiring.

- E. The boiler system control panel shall include contacts for a manual CSD-1 emergency shutdown switch. The switch shall be furnished, installed, and wired by the Temperature Controls Contractor. A switch shall be located at each exit just outside the boiler room door or as shown on plans. If boiler room door is on exterior of building, the switch shall be located just inside the door or as shown on plans. Verify final location with Architect/Engineer. The switch shall disable all boilers and shall be wired to the boiler burner safety control circuit to interrupt burner operation.
- F. The boiler shutdown switch shall be an emergency stop, mushroom head with N.C. contact, turn to release switch with engraved nameplate to read "BOILER EMERGENCY SHUTOFF". Square D XAL K174 or as approved by Architect/Engineer.
- G. For multiple boiler systems, furnish a boiler management system consisting of controller(s) capable of stopping, starting, and modulating all boilers to maintain maximum efficiency of the boiler plant. The boiler management system shall include all alarms, control points, and setpoints specified.
- H. Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the boiler package. Wiring between the boiler control panel(s) and the integration panel shall be the responsibility of the manufacturer.

## 2.7 PERFORMANCE

- A. Minimum gas-fired efficiency, verified by factory tests, shall be 86% at 100% output with 150°F return water and 88% at 25% output with 130°F return water.
- B. Rated for return temperatures as low as 40°F and supply temperatures as high as 190°F.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General Requirements:
  - 1. Install in accordance with manufacturer's instructions.
  - 2. Provide for connection to electrical service.
  - 3. Provide connection of gas service in accordance with ANSI/AGA Z223.1.
  - 4. Pipe safety relief valve and condensate trap to acid neutralizer kit and nearest floor drain.
  - 5. Install heating water circulation pump as recommended by the manufacturer.
- B. Combustion Inlet and Venting:
  - 1. Provide complete sealed combustion inlet and venting system.
  - 2. Slope all horizontal runs of exhaust vent towards the boilers at a slope of 1" per 4'.
- C. Service Clearance:
  - 1. Install the boilers with a minimum of three feet clear space behind them for installation of piping and services. Verify exact maintenance clearances required by the manufacturer prior to installation.

**3.2 MANUFACTURER'S FIELD SERVICES**

- A. Prepare and start systems under factory authorized supervision.
- B. Provide field representative for starting unit and training operator.
- C. Provide combustion test and submit report. Test shall include boiler firing rate, overfire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O<sub>2</sub>), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent combustion efficiency, and heat output.

END OF SECTION 235216

**SECTION 237413 - ROOFTOP MODULAR AIR HANDLING UNITS (DOAU-FR-1)****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Modular Outdoor Air Handling Units.

**1.2 QUALITY ASSURANCE**

- A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years' experience.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.
- C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- D. Sound Ratings: Tested to AMCA 300.
- E. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.
- F. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.
- G. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.
- H. Unit shall contain only UL listed components.
- I. Conform to ASHRAE 90.1.
- J. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

**1.3 REFERENCES**

- A. AMCA 208 - Calculation of the Fan Energy Index (FEI).
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- D. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters
- E. AMCA 99 - Standards Handbook.
- F. ANSI/AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- G. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- H. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

- I. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- J. AHRI 430 - Standard for Central-Station Air-Handling Units.
- K. ASHRAE/ANSI Standard 111 - Practices for Measurements, Testing, Adjusting and Balancing Heating, Ventilating, Air-Conditioning and Refrigeration Systems.
- L. NFPA 70 - National Electrical Code.
- M. NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- N. SMACNA - HVAC Duct Construction Standards (latest edition).
- O. Standard 62-2004 - Ventilation for Acceptable Indoor Air Quality (ANSI Approved).

#### 1.4 SUBMITTALS

- A. Submit shop drawings per Section 230500. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
  - 1. Product Data
    - a. Include data on all fans and accessories. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.
    - b. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops.
    - c. Submit sound power level data for both fan outlet and casing radiation at rated capacity.
    - d. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
    - e. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
    - f. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.
- B. Submit manufacturer's installation instructions.
- C. All base bid pricing shall be based on the drawings, schedules and this specification.
  - 1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.
  - 2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.
- D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.

- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
- G. Piezometer Flow Coefficients: Submittals for fans shall clearly indicate the size and associated flow coefficient for each fan included in the submittal as it relates to the piezometric airflow measuring system. Provide instructions indicating how the flow coefficient can be used in calculating fan airflow using the fan manufacturer provided empirically derived formulas for calculating airflow. Include recommended differential pressure controller  $\Delta P$  range inches w.g. based on scheduled maximum airflows.

### **1.5 EXTRA STOCK**

- A. Provide clean filters in all units at time of installation.
- B. Provide clean filters in all units at project final completion after all interior finishes are complete.
- C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
- B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

### **1.7 WARRANTY**

- A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.

### **1.8 GENERAL DESCRIPTION**

- A. Unit Location:
  1. The air handling unit (DOAU-FR-1) is a constant volume modular unit, located on the main level.
  2. The unit will be set on a concrete housekeeping pad by the Contractor.
- B. Building Type:
  1. The building is a steel structure with a precast concrete floor system (DOAU-1).
- C. Unit Description:
  1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
  2. Refer to air handling unit drawings and schedules for additional information.



## PART 2 - PRODUCTS

### 2.1 MODULAR OUTDOOR AIR HANDLING UNITS

#### A. Manufacturers:

1. Trane - Performance Climate Changer
2. Daikin - Skyline
3. Carrier - 39 Series
4. JCI/York - Solutions
5. Ventrol - ITF Outdoor Unit
6. Temtrol - Series ITF

#### B. Housing:

1. Minimum 18 gauge G90 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
2. Removable access panels for coil and fan removal.
3. Unit shall be double wall constructed and insulated in all sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.
4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
5. Units shall be draw-thru as noted on the drawings and shall not exceed the overall dimensions.
6. The external surface of the unit shall be factory painted to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing shall be prepared and coated with a minimum of 1.5 mil enamel finish.
7. The unit's roof shall be double wall constructed. The inner roof shall be installed in such a manner to prevent air bypass between internal components. The outer roof shall be sloped a minimum of 0.25" per foot either from one side of the unit to the other, or from the center to the sides of the unit. All seams shall be gasketed and capped to prevent water infiltration. The roof assembly shall have a drip seal that overhangs all the walls of the unit.
8. Provide unit with a full length, continuous, base rail channel. Base rail channels shall be formed of a minimum 12 gauge galvanized steel. Support all major components from base rail.

#### C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.
2. Door shall have a protective flange to shield gasket from exposure. Door frame shall be mounted on raised door frame and shall channel water away from gasket.
3. Doors shall contain a continuous neoprene bulb type gasket.
4. Each door shall contain a double pane tempered, reinforced or safety glass window.

5. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
6. Provide minimum 12" x 18" hinged access doors on both sides of the fan housing.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections.

E. Air Blender:

1. Shall be of rotary mixing design employing radial blades.
2. Shall be completely fixed devices with no moving parts.
3. Shall be provided with proper distances up and downstream such that the mixer is capable of providing a minimum mixing effectiveness of 75% and  $\pm 6^\circ\text{F}$  standard deviation when mixing 50% outside air with 50% return air at 50°F inlet temperature differential.
4. Shall be sized for maximum velocities between 1,000 and 1,500 FPM.

F. Fan:

1. Double Width, Double Inlet Centrifugal Fan(s), with Airfoil/Backward Inclined Blades:
  - a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type. Substitution of BI or BIA fans for FC is acceptable if efficiency is not lower.
  - b. Statically and dynamically balanced.
  - c. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.
  - d. Provide extended lubrication lines for all bearings to an easily accessible location.
  - e. Provide approved belt guards with openings for tachometer readings for external drives only.
  - f. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
  - g. Fan(s) shall have internal spring isolators.

G. Motors and Drives:

1. AC Induction Motors:
  - a. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
  - b. Motor mounting bracket shall be adjustable to allow tightening of belts.
  - c. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
  - d. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
  - e. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP (15 kW) and below. On units over 20 HP (15 kW), use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
2. No equipment shall be selected or operate above 90% of its motor nameplate rating. Electronically Commutated Motors (ECM):
  - 1) Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase. Motor frame shall be NEMA 48. UL recognized components shall be provided for the motor construction.

- b. All EC motors shall be a minimum of 85% efficient at all speeds.
  - c. Motors shall be permanently lubricated, utilize ball bearings to match with the connected driven equipment.
  - d. Provide motor with on-board motor control module. Motor speed shall be limited to provide electronic overcurrent protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- H. Variable Frequency Drives:
- 1. Provided and installed by unit manufacturer. Refer to Section 262923 for requirements.
- I. Pre-Filter Section:
- 1. Provide side-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 2" deep MERV-8 pleated media filters. Provide pre-filter module with full height hinged access door.
  - 2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
  - 3. Reference Section 234000 for filter requirements.
- J. Final Filter Section:
- 1. Provide front-loading final filter section located downstream of supply fan module as scheduled on drawings. Filter module shall be equipped with framing for 12" deep cartridge filters with seals on all four sides where each filter is inserted in the frame to prevent air bypass. Provide final filter module with full height hinged access door.
  - 2. Maximum final filter face velocity shall not exceed 400 feet/minute.
  - 3. Reference Section 234000 for filter requirements.
- K. Intake/Hood: Provide intake/exhaust hood of same construction as main unit casing. The hood shall be sized for scheduled air flow.
- L. Electrical Power:
- 1. Provide factory-mounted, weather-resistant (enclosed and gasketed), vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, receptacle, and bulb. Provide with factory-mounted outdoor service receptacles. Lighting and utility receptacles shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General Installation Requirements
- 1. Install per manufacturer's instructions.
  - 2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
  - 3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.

4. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

B. Coil Requirements:

1. Comb all coils to repair bent fins.
2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

**3.2 MANUFACTURER'S FIELD SERVICES**

- A. Provide factory authorized field representative for starting unit and training operator.
- B. Prepare and start systems with installing contractor observation.

END OF SECTION 237413

**SECTION 237416.12 - PACKAGED ROOFTOP AIR CONDITIONING UNITS 25 TON AND BELOW (RTU-FR-1)****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Packaged Rooftop Unit.
- B. Unit Controls.
- C. Roof Mounting Frame and Base.

**1.2 REFERENCES**

- A. AHRI 210 - Unitary Air Conditioning Equipment.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
- C. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.
- D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 90A - Installation of Air Conditioning and Ventilating System.
- G. UL - Underwriters' Laboratory.

**1.3 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 230500.
- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.
- D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

**1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

**1.6 WARRANTY**

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide standard year manufacturer's warranty for heat exchanger.
- C. Provide standard year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

**1.7 MAINTENANCE SERVICE**

- A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.
- D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- B. Trane
- C. Daikin
- D. Carrier

**2.2 FABRICATION**

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners locking door handle type with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.
- C. Insulation: Minimum of 1" thick 1.5lb./cuft. aluminum foil faced glass fiber on all sections.

- D. Heat Exchangers: Stainless steel, of welded construction.
- E. Air Filters: Two inch thick glass fiber disposable media in metal frames.

### **2.3 ROOF MOUNTING FRAME AND BASE**

- A. Roof Mounting Curb: Minimum 12 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

### **2.4 FANS/MOTORS**

- A. Fans:

1. Supply Fans: centrifugal; SWSI plenum or vane axial fan.
2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
3. Fan and motor assemblies shall be resiliently mounted.
4. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
6. All fans must be statically and dynamically balanced.

- B. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
3. Motor shall have 1.15 service factor.

- C. Belt Drive Fans:

1. Belt drive fans must be within  $\pm 10\%$  of scheduled RPM.
2. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.
3. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
4. Units used with variable speed drives shall have fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.

### **2.5 BURNER**

- A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot. Two stage.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

### **2.6 EVAPORATOR COIL**

- A. Provide copper tube with aluminum fin coil assembly.

- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.
- D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
- E. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. Factory installed in drain pan and wired to shut the rooftop unit down with a fault alarm. No standby power required.

## 2.7 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Provide capacity control by staging multiple compressors.

## 2.8 CONDENSER

- A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.
- B. Condenser Coil:
  1. Round Copper Tube and Aluminum Fins: Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Air test under water to 450 psig. Coils and frame shall include 5000+ hour salt spray resistance (ASTM B117-90).
  2. Microchannel: All aluminum brazed fin construction. The maximum allowable working pressure of the condenser is 450 psig. Air test under water to 450 psig. Coils and frame shall include 5000+ hour salt spray resistance (ASTM B117-90).
- C. Condenser Fans: Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.
- D. Condenser Motors: Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.



- E. Entire fan assembly shall be statically and dynamically balanced.
- F. Provide refrigerant pressure switches to cycle condenser fans.
- G. Provide hail guards on all condenser coils.

## 2.9 MIXING SECTION

- A. Dampers: Provide remote controlled outside and return air dampers with damper operator and remote rheostat for adjusting outside air quantity.

## 2.10 ECONOMIZERS

- A. To be controlled by dry bulb controller with minimum position setting.
- B. Shall be equipped with 100% capable relief barometric damper relieving up to 100% return air and sealed to meet ASHRAE 90.1 requirements.
- C. Shall be capable of introducing up to 100% outside air.
- D. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
- E. Dampers shall be capable of completely closing when unit is in unoccupied mode.
- F. Outside air damper normally closed and return air damper normally open.
- G. Provide factory installed and tested, outdoor air monitor that controls outdoor air  $\pm$  15% accuracy down to 40 cfm per ton.
- H. Economizer Fault Detection and Diagnostics (FDD):
  1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:
    - a. The following temperature sensors shall be permanently installed to monitor system operation:
      - 1) Outside air.
      - 2) Supply air.
      - 3) Return air.
    - b. Temperature sensors shall have an accuracy of  $\pm 2^{\circ}\text{F}$  over the range of  $40^{\circ}\text{F}$  to  $80^{\circ}\text{F}$ .
    - c. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  percent of full scale.
    - d. The unit controller shall be configured to provide system status by indicating the following:
      - 1) Free cooling available.
      - 2) Economizer enabled.
      - 3) Compressor enabled.
      - 4) Heating enabled.
      - 5) Mixed air low limit cycle active.
      - 6) The current value of each sensor.

- e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
- f. The fault detection and diagnostics system shall be configured to detect the following faults:
  - 1) Air temperature sensor failure/fault.
  - 2) Not economizing when the unit should be economizing.
  - 3) Economizing when the unit should not be economizing.
  - 4) Excess outdoor air.
- g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

## 2.11 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.
- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.
- C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- E. All units shall include a transformer for controls and convenience outlet.
- F. Only one power cable connection to the unit shall be necessary.
- G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

## 2.12 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Room thermostat shall incorporate:
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from set point.
  - 3. Set-up for four separate temperatures per day.
  - 4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
  - 5. Short cycle protection.
  - 6. Programming based on weekdays, Saturday and Sunday.
  - 7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.

- B. Room thermostat display shall include:
  1. Time of day.
  2. Actual room temperature.
  3. Programmed temperature.
  4. Programmed time.
  5. Duration of timed override.
  6. Day of week.
  7. System model indication: heating, cooling, auto, off, fan auto, fan on.
  8. Stage (heating or cooling) operation.
- C. Provide low limit sequence to close outside air dampers and stop supply fan.
- D. Mixed Air Controls: Maintain selected supply air temperature and revert dampers to minimum outside air position on a call for heating and above 75°F ambient, when ambient air enthalpy exceeds return air enthalpy.

### 2.13 OPERATING CONTROLS - VARIABLE VOLUME UNITS

- A. Operators Panel: An operator's panel may be used to control up to two central control panels. The 16-button keypad and 2 line/40-character display shall give the operator individual zone status and control from one location.
  1. Zone control functions include:
  2. Zone status includes:
    - a. Current zone temperature.
    - b. Current occupancy mode.
    - c. Current heat/cool mode.
  3. Time-of-day scheduling shall be available by group, individually for each of the four groups. Scheduling shall be two on/off periods per day for each of the seven weekdays. A holiday schedule shall also be available for each group. Up to 24 holiday dates can also be scheduled. Groups timed override can be enabled from the keypad for a two-hour period. Operator's panel shall have a 365 day clock with daylight savings time and leap year functions.

### 2.14 DDC TEMPERATURE CONTROLS

- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

**3.3 MANUFACTURER'S FIELD SERVICES**

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION 237416.12

**SECTION 237416.13 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - ABOVE 25 TON (RTU-1 AND RTU-2)****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Packaged Rooftop Unit.
- B. Unit Controls.
- C. Roof Mounting Frame and Base.

**1.2 QUALITY ASSURANCE**

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. Conform to IECC.
- E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

**1.3 REFERENCES**

- A. AHRI 210 - Unitary Air Conditioning Equipment.
- B. AHRI 240 - Air Source Unitary Heat Pump Equipment.
- C. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
- D. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.
- E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Installation of Air Conditioning and Ventilating System.
- H. UL - Underwriters' Laboratory.

**1.4 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 230500.

- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.
- D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- E. Provide 8 octave maximum sound power levels at unit discharge and return connection.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

### **1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

### **1.7 WARRANTY**

- A. Provide five (5) year manufacturer's warranty for compressors. Provide five (5) year manufacturer's warranty for heat exchanger.
- B. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

### **1.8 MAINTENANCE SERVICE**

- A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.
- D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 230500 for additional information.
- B. Trane

- C. Daikin
- D. Carrier

## 2.2 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners locking door handle type with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.
- C. Insulation: Minimum of 1" (1.5lb./cuft.) aluminum foil faced glass fiber on all sections. All sections shall be double wall, foam injected casings.
- D. Heat Exchangers: Stainless steel, of welded construction.
- E. Air Filters: Two inch thick glass fiber disposable media in metal frames.

## 2.3 ROOF MOUNTING FRAME AND BASE

- A. Roof Mounting Curb: Minimum 24 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

## 2.4 FANS/MOTORS

- A. Fans:
  1. Supply Fans: Airfoil DWDI centrifugal; SWSI plenum or vane axial fan.
  2. Return: Airfoil DWDI centrifugal; SWSI plenum or vane axial fan.
  3. Exhaust Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
  4. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
  5. Fan and motor assemblies shall be resiliently mounted.
  6. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
  7. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
  8. All fans must be statically and dynamically balanced.
- B. Motors:
  1. Motors shall be open drip-proof with grease lubricated bearings.
  2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 230513.
  3. No equipment shall be selected or operate above 90% of its motor nameplate rating.
  4. Motor shall have 1.15 service factor.

## 2.5 EVAPORATOR COIL

- A. Provide copper tube with aluminum fin coil assembly.

- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.
- D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
- E. Drain Pan Condensate Overflow Switch: Float with integral magnet overflow switch conforming to UL508. Factory installed in drain pan and wired to shut the rooftop unit down with a fault alarm. No standby power required.

## 2.6 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Provide capacity control by providing digital scrolls.

## 2.7 CONDENSER

- A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.
- B. Condenser Coil:
  1. Round Copper Tube and Aluminum Fins: Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Air test under water to 450 psig (3100 kPa gauge). Coils and frame shall include 5000+ hour salt spray resistance (ASTM B117-90).
  2. Microchannel: All aluminum brazed fin construction. The maximum allowable working pressure of the condenser is 450 psig (3100 kPa gauge). Air test under water to 450 psig (3100 kPa gauge). Coils and frame shall include 5000+ hour salt spray resistance (ASTM B117-90).
- C. Condenser Fans: Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.



- D. Condenser Motors: Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- E. Entire fan assembly shall be statically and dynamically balanced.
- F. Provide refrigerant pressure switches to cycle condenser fans.
- G. Provide hail guards on all condenser coils.

## 2.8 MIXING SECTION

- A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced.
- B. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.
- C. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

## 2.9 ECONOMIZERS

- A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.
- B. To be controlled by dry bulb controller with minimum position setting.
- C. Shall be capable of introducing up to 100% outside air.
- D. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
- E. Dampers shall be capable of completely closing when unit is in unoccupied mode.
- F. Outside air damper normally closed and return air damper normally open.
- G. Provide factory installed and tested, outdoor air monitor that controls outdoor air  $\pm$  15% accuracy down to 40 cfm per ton.
- H. Economizer Fault Detection and Diagnostics (FDD):
  - 1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:

- a. The following temperature sensors shall be permanently installed to monitor system operation:
  - 1) Outside air.
  - 2) Supply air.
  - 3) Return air.
- b. Temperature sensors shall have an accuracy of  $\pm 2^{\circ}\text{F}$  over the range of  $40^{\circ}\text{F}$  to  $80^{\circ}\text{F}$ .
- c. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  percent of full scale.
- d. The unit controller shall be configured to provide system status by indicating the following:
  - 1) Free cooling available.
  - 2) Economizer enabled.
  - 3) Compressor enabled.
  - 4) Heating enabled.
  - 5) Mixed air low limit cycle active.
  - 6) The current value of each sensor.
- e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
- f. The fault detection and diagnostics system shall be configured to detect the following faults:
  - 1) Air temperature sensor failure/fault.
  - 2) Not economizing when the unit should be economizing.
  - 3) Economizing when the unit should not be economizing.
  - 4) Damper not modulating.
  - 5) Excess outdoor air.
- g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

## 2.10 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.
- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- C. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- D. All units shall include a transformer for controls and convenience outlet.

- E. Only one power cable connection to the unit shall be necessary.
- F. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

### 2.11 OPERATING CONTROLS - VARIABLE VOLUME UNITS

- A. Temperature transmitter located in supply air shall signal electronic logic panel to control mixing dampers and cooling in sequence to maintain 55°F (adj.).
- B. Control cooling by modulating compressors.
- C. Control logic shall allow adjustable supply air reset under low load or airflow conditions.
- D. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- E. Provide two stage morning warm-up thermostat to hold outdoor dampers closed and energize heat until return air temperature reaches set point.
- F. Program Options: Each central control panel is individually configurable as an air conditioner controller for a variable volume system.
- G. Supply Air Temperature Sensor Input: The supply air temperature sensor monitors the air handling unit discharge air temperature. It is used by the central control panel to control the stages of heating and cooling, and to protect the air handling unit from excessively high or low discharge air temperatures. The leaving air temperature sensor requires twisted, shielded pair wire. Terminations are screw terminals.
- H. Operators Panel: An operator's panel may be used to control up to two central control panels. The 16-button keypad and 2 line/40-character display shall give the operator individual zone status and control from one location.
  1. Zone control functions include:
    - a. Occupied heat/cool setpoints.
    - b. Unoccupied heat/cool setpoints.
  2. Zone status includes:
    - a. Current zone temperature.
    - b. Current occupancy mode.
    - c. Current heat/cool mode.
  3. Time-of-day scheduling shall be available by group, individually for each of the four groups. Scheduling shall be two on/off periods per day for each of the seven weekdays. A holiday schedule shall also be available for each group. Up to 24 holiday dates can also be scheduled. Groups timed override can be enabled from the keypad for a two-hour period. Operator's panel shall have a 365 day clock with daylight savings time and leap year functions.

### 2.12 DDC TEMPERATURE CONTROLS

- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.

- B. Control module shall be compatible with temperature control system specified in Section 230900. Provide BACnet gateway for communication.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

#### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.

#### **3.3 MANUFACTURER'S FIELD SERVICES**

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION 237416.13

**SECTION 238126 - SPLIT SYSTEM AIR CONDITIONING UNITS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Split system air conditioning wall units.

**1.2 REFERENCES**

- A. ARI 210 - Unitary Air Conditioning Equipment
- B. ARI 240 - Air Source Unitary Heat Pump Equipment
- C. ANSI NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- D. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- F. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. ASHRAE 52 - Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- H. ASTM B1003 - Standard Specification for Seamless Copper Tube for Linesets.
- I. FS TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.
- J. UL - Underwriters' Laboratories.

**1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 230500.
- B. Indicate drain, electrical, and refrigeration rough-in connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading, and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location until units are ready for immediate installation.

**1.5 REGULATORY REQUIREMENTS**

- A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.
- B. Conform to ASHRAE 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

**1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

**1.7 WARRANTY**

- A. Provide five (5) year manufacturer's warranty on all compressors.

**PART 2 - PRODUCTS****2.1 SPLIT SYSTEM WALL AND CEILING-MOUNTED UNITS**

## A. Manufacturers:

1. Carrier/Toshiba
2. LG
3. Samsung
4. Daikin Applied
5. Trane/Mitsubishi

## B. Manufactured Units:

1. Provide packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, and controls. Wall-mounted units shall be furnished with integral wall mounting bracket and mounting hardware.
2. Assemble unit for wall-mounted or ceiling installation with service access required.
3. Performance shall be as scheduled on the drawings.
4. Unit shall be rated per AHRI Standards 210/240 and listed in the AHRI directory as a matched system.
5. Provide unit with factory-supplied cleanable air filters.
6. The units shall be listed by Electrical Laboratories (ETL) in accordance with UL-1995 certification and bear the ETL label.
7. All wiring shall be in accordance with the National Electric Code (NEC).

## C. Evaporator Cabinet and Frame:

## 1. Cabinet:

- a. Refer to schedule on drawings for mounting type (wall-mounted).
- b. Exposed units shall have a finished appearance with concealed refrigerant piping, condensate drain piping, and wiring connections.

D. Evaporator Fans and Motors:

1. Fans:

- a. The evaporator fan shall be direct drive with a single motor having permanently lubricated bearings.
- b. The fan shall be statically and dynamically balanced.
- c. The indoor fan shall have at least three speeds.

2. Motor:

- a. Direct driven, digitally controlled with multiple speeds. Permanently lubricated with internal overload protection.

E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve.
3. Coils shall be pressure tested at the factory.
4. A sloped, corrosion-resistant condensate pan with drain shall be provided under the coil.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code and local electrical codes.

G. Control:

1. The unit shall have a hard-wired 7-day programmable remote controller to operate the system. Provide wall mounting bracket for controller.
2. Remote controller shall have "automatic", "dry" (dehumidification), and "fan only" operating modes.
3. The remote controller shall have the following features:
  - a. On/Off power switch.
  - b. Mode Selector to operate the system in auto, cool, heat, fan, or dehumidification (dry) operation.
  - c. Fan Setting to provide multiple fan speeds.
  - d. Swing Louver for adjusting supply louver discharge.
  - e. On/Off Timer for automatically switching the unit off or on.
  - f. Temperature Adjustment allows for the increase or decrease of the desired temperature.
  - g. Powerful Operation to allow quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time.
4. The remote controller shall perform fault diagnostic functions that may be system related, indoor or outdoor unit related depending on the fault code.
5. Temperature range on the remote controller shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.
6. The indoor unit microprocessor shall have the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote controller.

7. Integration: Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the split system.

H. Outdoor Unit:

1. General:
  - a. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be completely factory assembled and pre-wired with all necessary electronic and refrigerant controls.
2. Cabinet:
  - a. The outdoor unit shall be fabricated of galvanized steel, bonderized and coated with a baked enamel finish for corrosion protection.
3. Fan:
  - a. The fan shall be direct drive, propeller type fan with fan guard.
  - b. Fan blades shall be statically and dynamically balanced.
  - c. The fan shall have permanently lubricated type bearings.
  - d. Motor shall be protected by internal thermal overload protection.
  - e. Airflow shall be horizontal discharge.
4. Coil:
  - a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
  - b. The coil shall be protected with an internal guard.
  - c. Refrigerant flow from the condenser shall be controlled via a metering device.
5. Compressor:
  - a. Hermetic or scroll refrigerant compressors with resilient suspension system, inverter driven, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.
  - b. The outdoor unit shall have an accumulator and four-way reversing valve.
6. Refrigerant:
  - a. Unit shall use R-410a.
  - b. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

I. Integral Condensate Pump:

1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
2. Provide alarm to indicate high level reservoir.
3. Unit shall be powered from evaporator unit with appropriate field connections available.

## 2.2 PIPING

- A. Design Pressure: 450 psig; Maximum Design Temperature: 250°F



- B. Type ACR Seamless Copper Tube Linesets; Brazed Joints:
1. 3/4" and under.
  2. Tubing: Type ACR seamless copper tube linesets, ASTM B1003. Sizes indicated are nominal designation.
  3. Joints: Brazed with silver solder.
  4. Fittings: Wrought copper solder joint, ANSI B16.22.
  5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged, and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
  6. Limitations:
    - a. Only between refrigerant splitter box and indoor terminal unit.
    - b. For use above ceiling only. Do not use in exposed areas.
- C. Refrigerant linesets are permitted.

### 2.3 INSULATION

- A. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Minimum 1/2" thick for pipe sizes less than 1-1/4" and 3/4" thick for pipe sizes 1-1/4" and above.

### 2.4 ROOF MOUNTING CURB

- A. Curb height as shown on drawings., minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. General Installation Requirements:
1. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
  2. Install units in accordance with manufacturer's instructions. Install all units level and plumb. Indoor units shall be installed using manufacturer's standard mounting hardware securely fastened to building structure.
  3. Refer to Section 230529 for roof support rails for outdoor unit.
  4. Coordinate the exact mounting location of all indoor and outdoor units with architectural and electrical work. Coordinate installation of ceiling-mounted units with ceiling grid layout. Provide additional ceiling grid reinforcement or modification as required and coordinate the work with the GC. Locate the indoor unit where it is readily accessible for maintenance and filter changes. Where outdoor units are located on the roof, locate at least 10' from the roof edge.

5. Verify locations of wall-mounted remote controllers with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48".
  6. Maintain minimum clearances to all equipment. Maintain manufacturer's minimum maintenance, and airflow clearances, and maintain minimum spaces about electrical equipment, whichever is greater.
    - a. 120V: 36" deep x 30" wide or the width of the panel whichever is wider.
    - b. 208V: 42" deep x 30" wide or the width of the panel whichever is wider.
    - c. 480V: 42" deep x 30" wide or the width of the panel whichever is wider.
- B. Condensate Removal:
1. Install condensate piping with trap and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or to a properly vented indirect waste fitting. Flush all piping before making final connections to units.
- C. Comb all coils to repair bent fins.
- D. Install new filters in the unit at Substantial Completion.
- E. A factory-authorized service agent shall assist in commissioning the unit and inspecting the installation prior to startup. Submit startup report with O&M manuals.

### 3.3 REFRIGERANT PIPING

- A. Install refrigerant piping from the indoor unit(s) to the condensing unit. Refrigerant pipe sizes, lengths, specialties and configurations shall be as recommended by the manufacturer. Evacuate refrigerant piping and fully charge system with refrigerant per manufacturer's requirements.
- B. Provide weather-tight insulated roof curb to accommodate refrigerant piping and conduit roof penetrations.
- C. Insulate all refrigerant piping. Both liquid and suction lines shall be insulated between the indoor and outdoor units.
- D. Insulation:
1. Insulate all refrigerant pipes between the heat pump and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and heat pump units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer's literature or required by local AHJ:
    - a. Code/Year: IECC 2018
    - b. Refrigerant Suction (40°F & Below):
      - 1) Up to 1": 1/2"
      - 2) 1" and up: 1"

c. Refrigerant Suction (41°F to 60°F):

- 1) Up to 1-1/2": 1/2"
- 2) 1-1/2" and up: 1"

d. Refrigerant Liquid:

- 1) Up to 1-1/2": 1"
- 2) 1-1/2" and up: 1-1/2"

END OF SECTION 238126

**SECTION 238200 - TERMINAL HEAT TRANSFER UNITS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Finned Tube Radiation.
- B. Unit Heaters.
- C. Electric Unit Heaters.

**1.2 QUALITY ASSURANCE**

- A. All electrical equipment shall have a UL label.
- B. Factory wired equipment shall conform to ANSI/NFPA 70.

**1.3 REFERENCES**

- A. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NFPA 70 - National Electrical Code.
- D. ASHRAE 200 - Methods of Testing Chilled Beams

**1.4 SUBMITTALS**

- A. Submit shop drawings per Section 230500.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

**1.6 REGULATORY REQUIREMENTS**

- A. Conform to ASHRAE 90.1.

**1.7 OPERATION AND MAINTENANCE DATA**

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

**PART 2 - PRODUCTS****2.1 FINNED TUBE RADIATION - PEDESTAL MOUNT**

- A. Cabinets shall be minimum 16 gauge steel with baked enamel finish.
- B. Final color selection shall be as scheduled on the drawings.
- C. Provide end caps, corner pieces, adjustable extensions, and other accessories required for proper appearance and service.
- D. Provide supports with aluminum finish.
- E. Provide access doors at all valves if cabinet is not easily removable.
- F. All cabinet and accessories shall be securely connected with no exposed fasteners.
- G. Support 1/2" tubes on 36" centers and larger tubes on 48" centers.
- H. Elements shall be copper tube with aluminum fins.
- I. Cabinet size, element length and element size shall meet the scheduled capacities, but not be less than the sizes scheduled.
- J. Products:
  - 1. Vulcan 'Lino-Vane.'
  - 2. Sterling - 'PM.'
  - 3. Zehnder-Rittling 'ETL.'

**2.2 UNIT HEATERS**

- A. Casings shall be heavy gauge steel with a baked finish.
- B. Coils shall have copper heads and tubes, and aluminum fins.
- C. Units shall have threaded pipe connections for hanger rods.
- D. Fans shall be direct drive propeller type, factory balanced, with fan guards and totally enclosed motors with integral thermal overload protection.
- E. Horizontal units shall have adjustable outlet air louvers.
- F. Provide unit mounted and wired disconnects. Contractor shall be responsible for providing and wiring disconnect when using a manufacturer who does not provide factory mounted option.

- G. Products:
1. Modine - HS or V.
  2. Sterling HS or VS.
  3. Zehnder-Rittling - H or V.

### 2.3 HOT WATER AND STEAM CABINET HEATERS

- A. Units shall include cabinet, fan, motor, coil, filter, inlet grille and discharge grille.
- B. Cabinets: 16 gauge exposed surfaces and 18 gauge concealed surfaces. Plastic exposed parts are not acceptable.
- C. Baked enamel finish. Color selected by Engineer .
- D. All motors shall be three-speed permanent split capacitor with integral thermal overload protection.
- E. Coils shall have finned copper tubes.
- F. Provide 1" thick disposable filters or 1/2" thick washable 65% aluminum filters ahead of all coils.
- G. Provide a concealed unit mounted fan switch with "Off-High-Medium-Low" positions that doubles as disconnect.
- H. Manufacturers:
1. Sterling, Modine.
  2. Zehnder-Rittling.
  3. Airtherm.
  4. Daikin.

### 2.4 ELECTRIC UNIT HEATERS

- A. Horizontal or vertical discharge as scheduled on the drawings.
- B. Horizontal units shall have adjustable outlet louvers.
- C. Metal sheathed fin tube electric heating elements.
- D. Casing: Heavy gauge steel with baked enamel finish.
- E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.
- F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.
- G. Provide unit mounted and wired disconnect.
- H. Provide resiliently mounted fan guard/motor support.
- I. Fans: Direct drive propeller type, factory balanced.

J. Manufacturers:

1. Modine.
2. Reznor.
3. Berko.
4. Redd-i.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

A. General Installation Requirements:

1. Install all products per manufacturers' instructions.
2. Coordinate recess sizes for recessed equipment.
3. Protect units with protective covers during construction.
4. Comb all coils to repair bent fins.

B. Fin Tube:

1. Locate finned tube radiation as shown and run cover wall-to-wall, unless otherwise shown. Center elements under windows.

C. Unit Heater:

1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer's recommended mounting height requirements. If unit heaters cannot be installed within manufacturer's recommended range, notify Architect/Engineer prior to mounting.

#### **3.2 CLEANING**

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 238200

**SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 270528. This section is also applicable to Fire Alarm and Detection Systems Section 283101.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

**1.2 REFERENCES**

- A. NFPA 70 - National Electrical Code (NEC)

**1.3 SCOPE OF WORK**

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.
- C. Separate contracts will be awarded for the following work.
- D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- F. Description of Systems shall be as follows:
  - 1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
  - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
  - 3. Grounding system.
  - 4. Fire alarm system.
  - 5. Public address and intercom system.
  - 6. Nurse call system.
  - 7. Clock and program system.
  - 8. Security system.
  - 9. Rescue assistance communication system.
  - 10. Distributed antenna system (DAS).
  - 11. Wiring system for temperature control system as shown on the drawings.
  - 12. Lightning protection system.
  - 13. Wiring of equipment furnished by others.
  - 14. Removal work and/or relocation and reuse of existing systems and equipment.



15. Telecommunications rough-in, as shown on drawings, for installation of telecommunications equipment by others under separate contract.
16. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.
17. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.

G. Work Not Included:

1. Telecommunications cabling will be by Division 27, in raceways and conduits furnished and installed as part of the Electrical work.
2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

#### 1.4 OWNER FURNISHED PRODUCTS

A. The Owner will supply the following items for installation and/or connection by this Contractor:

1. Radio Tower.
2. Radio Room Furniture
3. Automatic Car Lifts
4. Vending Machines
5. Projectors

B. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.

C. This Contractor shall make all electrical system connections shown on the drawings or required for fully functional units.

D. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

#### 1.5 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

B. Schedule overtime hours as needed to complete project schedule.

C. Itemize all work and list associated hours and pay scale for each item.

#### 1.6 ALTERNATES

A. Alternate 1: Waste Heater.

B. Alternate 4: 800kW generator with a 72 hour tank.

## 1.7 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
  2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
  3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
  4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
  5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
  6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
  7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
  8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
  9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
  10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.
- C. General:
1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Luminaires.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical bus duct.
  - d. Sheet metal.
  - e. Cable trays, including access space.
  - f. Other piping.
  - g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.

4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.8 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

- a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
  3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
  2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

- a. Scale of drawings:
  - 1) General plans: 1/4 Inch = 1'-0" (minimum).
  - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
  - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
  - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
  - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.9 QUALITY ASSURANCE

### A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

### B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

### D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.
8. Pay all telephone company charges related to the service or change in service.

E. Utility Company Requirements:

1. Secure from the private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
4. The contractor is responsible for completing utility requested forms and sharing utility requested load data from the construction documents.
5. Furnish the meter socket metering compartment with CT space within the main switchboard. Verify approved manufacturers and equipment with the Utility Company.
6. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.

F. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.



## G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

## H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

**1.10 SUBMITTALS**

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawing
26 05 03	Through Penetration Firestopping	
26 05 13	Wire and Cable	
26 05 26	Grounding and Bonding	
26 05 33	Conduit and Boxes	+> 1.5"
26 05 53	Electrical Identification	
26 05 73	Power System Study	
26 09 33	Lighting Control System	
26 22 00	Dry Type Transformers	Yes
26 24 13	Switchboards	Yes
26 24 16	Panelboards	Yes
26 27 26	Wiring Devices	Ceiling mount
26 28 13	Fuses	
26 28 16	Disconnect Switches	Yes
26 32 13	Packaged Engine Generator Systems	Yes
26 36 00	Transfer Switch	Yes
26 43 00	Surge Protection Devices	
26 51 19	LED Lighting	Yes

Referenced Specification Section 28 31 01 Drawings	Submittal Item Fire Alarm and Detection Systems Photocells, Timeclocks, Relays	Coordination Drawing Yes
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- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
    - a. Date
    - b. Project title and number
    - c. Contractor's name and address
    - d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
    - e. Description of items submitted and relevant specification number
    - f. Notations of deviations from the contract documents
    - g. Other pertinent data
  2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
    - a. Date
    - b. Project title and number
    - c. Architect/Engineer
    - d. Contractor and subcontractors' names and addresses
    - e. Supplier and manufacturer's names and addresses
    - f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
    - g. Description of item submitted (using project nomenclature) and relevant specification number
    - h. Notations of deviations from the contract documents
    - i. Other pertinent data
    - j. Provide space for Contractor's review stamps
  3. Composition:
    - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
    - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
    - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
  - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal, excluding mailing.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 26 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

### 1.11 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.
- C. Preparation:
  1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
  2. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.

3. Itemize the cost for each of the following:
  - a. Overhead and profit.
  - b. Bonds.
  - c. Insurance.
  - d. General Requirements: Itemize all requirements.
  
4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
  - a. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
  - b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.
  - c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
  - d. Fire alarm broken down into material and labor for the following:
    - 1) Engineering
    - 2) Controllers, devices, sensors, etc.
    - 3) Conduit
    - 4) Wiring
    - 5) Programming
    - 6) Commissioning
  - e. Site utilities (5' beyond building)
  - f. Seismic design
  - g. Testing
  - h. Commissioning
  - i. Record drawings
  - j. Punchlist and closeout
  
- D. Update Schedule of Values when:
  1. Indicated by Architect/Engineer.
  2. Change of subcontractor or supplier occurs.
  3. Change of product or equipment occurs.

#### 1.12 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

**1.13 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE**

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

**1.14 NETWORK / INTERNET CONNECTED EQUIPMENT**

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.
- B. The following network connected equipment shall be equipped with restricted access protocols:
  1. Adjustable trip overcurrent protection devices
  2. Power monitoring and control
  3. Electrical controls
  4. Lighting control system
  5. Variable frequency drives
  6. Package engine generator and remote annunciator
  7. Transfer switch and remote annunciator
  8. Static uninterruptible power supply (UPS)
  9. Fire alarm and automatic detection

**1.15 WARRANTY**

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

**1.16 INSURANCE**

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

**1.17 MATERIAL SUBSTITUTION**

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

## **PART 3 - EXECUTION**

### **3.1 JOBSITE SAFETY**

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### **3.2 EXCAVATION, FILL, BACKFILL, COMPACTION**

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.



12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.
- C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
  2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
  2. Provide all necessary sand and/or CA6 for backfilling.
  3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
  4. Dispose of the excess excavated earth as directed.
  5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
  6. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
  7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
  8. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.
  9. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.
  10. Backfill with native soil material (if approved) or sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
  11. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
  12. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
  13. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
  - a. All junction boxes are closed and identified in accordance with Section 260553 Electrical Identification.
  - b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
  - c. Luminaire whips are supported above the ceiling.
  - d. Conduit identification is installed in accordance with Section 260553 Electrical Identification.
  - e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
  - f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

### 3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. IDPH Pre-Occupancy Requirements:

1. Each Contractor must submit all forms and certifications required by IDPH relating to their work at 85% completion of the project or when directed by the Owner/Architect/Engineer.

## C. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

## D. The following must be submitted before Architect/Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and submit receipt to Architect/Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.
6. Start-up reports on all equipment requiring a factory installation or start-up.

## E. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

**3.5 OPERATION AND MAINTENANCE MANUALS**

## A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

## B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div26.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

**3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE**

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. The instructions shall include:
  - 1. Maintenance of equipment.
  - 2. Start-up procedures for all major equipment.
  - 3. Description of emergency system operation.
- F. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- G. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.
- H. Operating Instructions:
  - 1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
  - 2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

**3.7 RECORD DOCUMENTS**

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.
- F. Record actual routing of conduits exceeding 2 inches.

### **3.8 ADJUST AND CLEAN**

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### **3.9 SPECIAL REQUIREMENTS**

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.
- D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.
  - 1. Elevator machine rooms and hoistways.
  - 2. Exit enclosures.
  - 3. Other areas restricted by code.
  - 4. Technology, data, server rooms.
  - 5. Fire pump and sprinkler rooms.
  - 6. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.
  - 7. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

### **3.10 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION**

- A. Within the Limits of Construction:
  - 1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.
  - 2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.
- B. Outside the Limits of Construction:
  - 1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.

2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
  3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.
- C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
1. General Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
  2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.
    - a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.
    - b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.
    - c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.
    - d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.
    - e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross sectional area to minimize the pressure drop and avoid the need for rebalancing.
    - f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.
  3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    - a. Minimizing the amount of dust generated.
    - b. Reducing solvent fumes and VOC emissions.
    - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
  4. Request that the Owner designate an IAQ representative.
  5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
  6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
  7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
  8. Request copies of and follow all Owner's IAQ and infection control policies.

9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

### **3.11 SYSTEM STARTING AND ADJUSTING**

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### **3.12 FIELD QUALITY CONTROL**

- A. General:
  1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
  2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
  3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
  4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
  5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
  6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.



**B. Ground Resistance:**

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain. Ground resistance values shall be verified by the Architect/Engineer at the time the readings are taken.
3. If the ground resistance value obtained is more than the value set forth in Section 260526, the following shall be done to obtain the value given:
  - a. Verify that all connections in the service ground system are secure.
  - b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
  - c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
  - d. Review results with the Architect/Engineer.
4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
  - a. Date of test.
  - b. Number of hours since the last rain.
  - c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
  - d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
  - e. Make, model, and calibration date of test equipment.
  - f. Tabulation of measurements taken and calculations made.

**C. Ground-Fault Equipment Performance Testing:**

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
  - a. Service disconnects
  - b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
  - c. Fusible switches with ground fault relay protection.
  - d. Outside branch circuits and feeders.
  - e. Code required.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

**D. Arc Energy Reduction Equipment Performance Testing:**

1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:
  - a. All arc energy reduction systems installed.

2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.
- E. Other Equipment:
1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.
- G. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.
- H. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.
- I. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

### **3.13 UTILITY REBATE**

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
- B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
- 2. Electrical panels have typed circuit identification.
- 3. Smoke and fire/smoke dampers are wired and have been tested.
- 4. Per Section 260500, cable insulation test results have been submitted.
- 5. Per Section 260500, ground resistance test results have been submitted.
- 6. Operation and Maintenance manuals have been submitted as per Section 260500.
- 7. Bound copies of approved shop drawings have been submitted as per Section 260500.
- 8. Report of instruction of Owner's representative has been submitted as per Section 260500.
- 9. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
- 10. Start-up reports from factory representative have been submitted as per Section 260500.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 260500

**SECTION 260503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. The Building Officials and Code Administrators National Building Code
- J. 1997 Uniform Building Code
- K. 2018 International Building Code
- L. NFPA 5000 - Building Construction Safety Code

**1.4 SUBMITTALS**

- A. Submit under provisions of Section 260500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Interek / Warnock Hersey Assembly number.

- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
1. Types of penetrating items.
  2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  4. F ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

### **1.6 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  2. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. at both ambient temperature and 400°F.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Products Division
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk
  4. Tremco; Sealant/Weatherproofing Division
  5. Johns-Manville
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Wiremold/Legrand: FlameStopper
  10. Dow Corning Corp
  11. Fire Trak Corp
  12. International Protective Coating Corp

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.

- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- F. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

- a. F Rating = Floor/Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall/Floor Rating
- b. L Rating = Penetrations in Smoke Barriers

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- H. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### **3.2 INSTALLATION**

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.



- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### **3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### **3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION 260503

**SECTION 260513 - WIRE AND CABLE****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Building wire
- B. Cabling for remote control, signal, and power limited circuits
- C. Fire rated and circuit integrity (CI) cable and assemblies
- D. Armored cable (AC)
- E. Metal-clad cable (MC)
- F. Nonmetallic-sheathed cable (NM)

**1.2 RELATED WORK**

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

**1.3 REFERENCES**

- A. ASTM B800-05 - Standard Specification for 8000 Series Aluminum Alloy Wire Electrical Purposes-Annealed and Intermediate Tempered.
- B. ASTM B801-07 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
- C. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- D. NFPA 70 - National Electrical Code (NEC)
- E. UL 44 - Thermoset-Insulated Wires and Cables
- F. UL 83 - Thermoplastic-Insulated Wires and Cables
- G. UL 854 - Service-Entrance Cables
- H. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords
- I. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

**1.4 SUBMITTALS**

- A. Submit shop drawings and product data under the provisions of Section 260500.
- B. Submit manufacturer's installation instructions.

## PART 2 - PRODUCTS

### 2.1 BUILDING WIRE

- A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
- C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings. Aluminum, compact stranded conductor is not acceptable for feeder and branch circuits 6 AWG and smaller.
- D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings. Three conductor stranded copper, 600-volt XHHW-2 insulation, with copper ground and overall helical copper tape shield. Shield shall be terminated at both ends of cable with an approved termination.
- E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
- F. Aluminum conductors are not to be used for feeds to motor loads.
- G. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

### 2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
  - 1. Fire alarm
  - 2. Low voltage switching and lighting control
  - 3. Electronic control
  - 4. Other specialized cabling, signal, and power limited cabling. Refer to the appropriate Division 23, 27, or 28 requirements; including, but not limited, to the following:
    - a. Building Automation Systems and Controls, Division 23.
    - b. Information Technology Backbone and Horizontal Cabling, Division 27.
    - c. Television Distribution Systems CATV, Division 27.
    - d. Distributed Cellular Antenna Systems, Division 27.
    - e. Distributed Antenna System (First Responder), Division 28.
    - f. Electronic Access Control, Intrusion Detection Systems, Video Surveillance, Division 28.
    - g. Rescue Assistance Communication System, Division 28.
- B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

## 2.3 FIRE-RATED AND CIRCUIT INTEGRITY (CI) CABLE AND ASSEMBLIES

- A. Properties and requirements of fire rated cables and assemblies:
1. 2HR fire rated for horizontal and vertical installations.
- B. Acceptable fire-rated cables and listed assemblies:
1. Feeder assembly located outside the structure (example: below finished grade), rated metal stud and drywall enclosure, or encased in concrete; minimum 2 inches of concrete).
    2. Exothermal Mat Material: Raceway / Cable protected with exothermic mat material, UL listed.
      - a. Install per manufacturer guidelines and requirements. Apply appropriate quantity of wrapped layers of material as required to achieve rating.
      - b. Contractor shall upsize cable / wiring / raceway sizes as required for derating.
      - c. Provide cable / wire ampacity derating calculations for each application, reference manufacturer for additional information, document and submit derated calculations as a shop drawing submittal for approval prior to installation. Minimum cable / wire derating shall be:
        - 1) Individual conduit raceways (less than or equal to 4" trade size): 10%.
        - 2) Parallel conduit raceways associated with the same feeder and protected by a common installation assembly: 15%.
        - 3) Cable tray raceway: 50%.
      - d. Manufacturer:
        - 1) 3M Interam Endothermic Mat
        - 2) Or submitted for engineer review prior to bid.
  3. Mineral Insulated Cables: Copper conductor, 600-volt insulation, rated 90°C, Type MI.
    - a. Manufacturer:
      - 1) Raychem Pyrotenax MI
  4. MC Cable: Copper conductor, 600V thermoset, low smoke zero halogen silicone rubber insulation, continuously welded corrugated copper armor for equipment grounding conductor, rated 90°C, UL listed 2196. MC fire rated cable shall not be used for branch circuits that required redundant equipment ground paths per code.
    - a. Manufacturers:
      - 1) VITALink MC
      - 2) Draka Lifeline MC Series
  5. Fire rated cable in EMT or IMC raceway: Copper conductor, 300-volt or ethernet power-limited circuit cables low smoke zero halogen (LSZH), rated 105°C. Assembly including raceway shall be UL listed 2196 and UL circuit integrity (FHIT).
    - a. Manufacturers:
      - 1) VITALINK CI/CIC or ethernet series

## 2) Draka RHW-2 EMT Series

6. Fire rated cable in phenolic RTRC conduit: Copper conductor, 600-volt RHW-2 or RW90 low smoke zero halogen (LSZH) insulation, rated 90°C. Assembly shall be UL listed 2196 and UL circuit integrity (FHIT).

## a. Manufacturer:

## 1) Draka Lifeline RHW-2

**2.4 ARMORED CABLE (AC)**

- A. Conductors shall be copper, 600-volt insulation, THHN. Armored cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Armored Cables, UL 4, and include flexible metallic interlocked armor.
- B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.
- C. Armored cables may be used for branch circuit wiring in non-patient care areas as defined in the Electrical Code, subject to acceptance by State and local codes.
- D. Armored cable shall NOT be used for circuits serving the Essential Electrical System.

**2.5 METAL-CLAD CABLE (MC)**

- A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 15694, exterior of metal interlocked armor.
- B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.
- C. Metal-clad cables may be used for branch circuit wiring in non-patient care areas as defined in the Electrical Code, subject to acceptance by State and local codes.
- D. Metal-clad cable shall NOT be used for circuits serving the Essential Electrical System.

**2.6 NONMETALLIC-SHEATHED CABLE**

- A. Nonmetallic-Sheathed Cable, Size 14 through 4 AWG:
1. Copper conductor, 600-volt insulation, rated 90°C, Type NM. Nonmetallic-sheathed cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Nonmetallic-sheathed Cables, UL 719.
  2. An equipment grounding conductor shall be provided with circuit conductors in all cables. Size per Electrical Code.
  3. Nonmetallic-sheathed cables may be used for branch circuit wiring as defined in the Electrical Code. Nonmetallic-sheathed cables shall not be used for other circuits.
- B. Underground Feeder and Branch Circuit Cable: Copper conductor, 600-volt insulation, rated 60°C, Type UF.
- C. Service Entrance Cable: Copper conductor, 600-volt insulation, XHHW, Type USE.

## **PART 3 - EXECUTION**

### **3.1 WIRE AND CABLE INSTALLATION SCHEDULE**

- A. Above Accessible Ceilings:
  - 1. Building wire shall be installed in raceway.
  - 2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type "THHN".
- D. Underground or In Slab: All conductors shall be type "THWN".
- E. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
  - 1. J-hooks
  - 2. Bridle rings with saddle supports
- F. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.
- G. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

### **3.2 CONTRACTOR CHANGES**

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)). Service entrance and fire pump feeder conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.2(7) (2011 - 2017 edition Table B310.15(B)(2)(7); 2008 or later edition B.301.7) or calculated in accordance with Annex B Application Information for Ampacity Calculation..
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.
- D. Conductor length(s) listed on plans and schedules. The drawings are diagrammatic with intent to convey the components of the electrical distribution system. Conductor length(s) when listed on plans and schedules are for engineering calculation purposes. Conductor length(s) shall NOT be used for bidding purposes.
- E. Record drawing shall include the calculations and sketches.

### 3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.
- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

### 3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires. Do not use wire pulling lubricant for isolated (ungrounded) power system wiring.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
  - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
  - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

### 3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.
- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.



### 3.6 FIRE-RATED CABLE AND ASSEMBLY INSTRUCTIONS

- A. Terminations of the fire-rated cable must be outside of the fire zone.
- B. Fire-rated cable shall be installed according to the manufacturer's instructions, recommendations, and UL listing.
- C. Route fire-rated cable and assemblies separate from other feeders and distribution. Install cable and assemblies in locations protected from physical damage.
- D. Refer to Electrical Identification Section 260553 for specific identification requirements.

### 3.7 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
  - 1. Facing the front and operating side of the equipment, the phase identification shall be:
    - a. Left to Right - A-B-C
    - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.
- K. Use antioxidant joint compound on all aluminum conductor terminations. Apply antioxidant joint compound per manufacturer's recommendations.

**3.8 AC, MC, AND NONMETALLIC-SHEATHED CABLE INSTALLATION**

- A. AC/MC shall NOT be used for circuits serving the Essential Electrical System.
- B. Cable shall be supported by an approved means every 4.5' and within 12" of outlet boxes, junction boxes, cabinets, or fittings.
- C. Cable may be unsupported in the following conditions:
  - 1. Cable is no longer than 2' in length at terminals where flexibility is necessary.
  - 2. Cable is not more than 4.5' from the last point of support for connections within an accessible ceiling to light fixtures or equipment.
- D. Conductor ampacity shall be derated as required by the Electrical Code where more than three current carrying conductors are used.
- E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.
- F. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.
- G. Bending radius shall comply with the requirements listed in the Electrical Code for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.
- H. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.
- I. All wiring devices supplied by nonmetallic-sheathed cables shall be mounted in an outlet box.

**3.9 FIELD QUALITY CONTROL**

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.
- D. Inspect wire and cable for physical damage and proper connection.
- E. Torque test conductor connections and terminations to manufacturer's recommended values.
- F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

- G. Provide documentation of the manufacturer's recommended lug torque value for copper and aluminum conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- H. Protection of wire and cable from foreign materials:
  - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
  - I. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION 260513

**SECTION 260526 - GROUNDING AND BONDING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system
- D. Grounding of systems over 1kV
- E. Substation grounding

**1.2 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
- B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with UL 467 Grounding and Bonding Equipment.
- E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- F. Comply with Electrical Code; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

**1.3 REFERENCES**

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 99 - Standard for Healthcare Facilities

**1.4 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 260500.
- B. Product Data: For the following:
  - 1. Ground rods.
  - 2. Chemical electrodes.
- C. Product Data: For each type of product indicated.

- D. Field Test Reports: Submit written test reports to include the following:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Indicate layout of ground field, location of system grounding electrode connections, and routing of grounding electrode conductor and ground ring.

## 1.5 SUMMARY

- A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

## PART 2 - PRODUCTS

### 2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 260513 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 260553 for insulation color.
- D. Isolated Ground Conductors: Insulated. Refer to Section 260553 for insulation color.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Copper Bonding Conductors: As follows:
  1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
  2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
  3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- H. Aluminum Bonding Conductors: As follows:
  1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
  2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.
  3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.
- I. GB; Grounding Bar:
  1. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" x 2", length of technology or applicable room.

- J. IBT; Intersystem Bonding Termination:
1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
  2. Manufacturers:
    - a. Harger GBI Series.
    - b. Erico EGB Series.

## 2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.
- D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods Copper-clad steel Stainless steel.
- B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.
- C. Test Wells: Provide handholes as shown on drawings or as specified in Division 2 Section "Underground Ducts and Utility Structures."
- D. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2" steel reinforcing bar.

## PART 3 - EXECUTION

### 3.1 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.
- H. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.
- I. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.
- J. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- K. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### **3.2 INSTALLATION**

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

- D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- E. In raceways, use insulated equipment grounding conductors.
- F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.
- G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

### **3.3 EQUIPMENT GROUNDING SYSTEM**

- A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:
  - 1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
  - 2. Single-phase and three-phase motor and appliance branch circuits.
  - 3. Flexible raceway runs, including FMC and LFMC.
  - 4. Armored and metal-clad cable runs.
- D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- F. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- G. Isolated Grounding Circuits: Install an insulated equipment grounding conductor connected to the receptacle or equipment grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at isolated equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

### **3.4 BONDING SYSTEM**

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.



- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.
- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.
- E. Bond metal ducts of dust collectors, particulate conveying, fume hoods, and other hazardous materials to the equipment grounding conductors of associated pumps, fans, or blowers. Use braided-type bonding straps. Provide braided bare copper bonding conductor in nonmetallic dust collector ductwork to each equipment inlet location, and bond to equipment.
- F. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.
- G. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.
- I. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.
- J. Industrial Control Panels, Terminal Cabinets, and Similar Installation: Terminate bonding conductor on cabinet grounding terminal. Provide an equipment grounding conductor and bond adjacent and associated control panels together.
- K. Equipment Ground Conductor Continuity: All spliced equipment grounding conductors in junction boxes, cabinets, and distribution equipment shall be connected together and bonded to the metal enclosure.
- L. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.
- M. Metal Poles Supporting Outdoor Lighting Fixtures > 15 feet: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.
- N. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- O. Medical Gas Piping: Bond to pipe with grounding clamp connectors. Bonding conductor shall be a #6 AWG minimum and may be connected to panelboard ground bar serving the area.

### 3.5 GROUNDING ELECTRODE SYSTEM

- A. Ground Ring (Counterpoise):
  - 1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at average distances not more than 60 feet apart. Provide a grounding conductor, electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2 AWG for ground ring and for tap to building steel. Bury conductor not less than 30 inches below grade, 24 inches from building foundation, and 18 inches outside of roof drip line.
- B. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
- C. Provide bonding at Utility Company's metering equipment and pad mounted transformer.
- D. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
  - 1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
  - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters, filtering devices, and similar equipment. Connect to pipe with grounding clamp connectors.
- G. Natural Gas Service Piping: Bond to natural gas main service with grounding clamp connectors. Bonding conductor shall be connected to the main service ground bar. Provide grounding jumpers around all breaks in metallic continuity.
- H. Natural Gas Equipment Piping: Bond each aboveground portion of natural gas metallic piping system at each equipment location with grounding clamp connectors. Bonding shall be performed after any flexible attachment nearest the equipment. The equipment grounding conductors may serve as the bonding means.
- I. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

- J. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches of concrete horizontally within the foundation that is in contact with the earth. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

### **3.6 CONCRETE OR WOOD BUILDING GROUNDING SYSTEM**

- A. Provide a copper common grounding electrode conductor for the attachment of multiple separately derived systems in accordance with Electrical Code. Individual grounding conductor taps from the separately derived systems to the common grounding electrode shall be sized in accordance with Electrical Code. All tap connections shall be made in an accessible location in such a manner that common grounding electrode conductor remains without a splice or joint.

### **3.7 EQUIPOTENTIAL (MULTI-POINT) GROUNDING SYSTEM**

- A. Provide an equipotential grounding system in the following locations:
1. Class I Div 1 and Div 2 locations as required in Electrical Code.
  2. Swimming pool, fountains, and similar locations as required in Electrical Code.
  3. Critical patient care and special care areas as indicated on drawings.
- B. The non-current-carrying metal parts of equipment, raceways and other enclosures shall be bonded to the grounding system.

### **3.8 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING**

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation. The pad rebar shall be attached to the counterpoise conductor at the four corners.

### **3.9 OVERHEAD-LINE GROUNDING**

- A. Comply with IEEE C2 requirements. Use 2 or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.

- B. Drive ground rods to a depth of 12 inches below finished grade in undisturbed earth.
- C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.
- D. Lightning Arresters: Separate arrester grounds from other grounding conductors.
- E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.
- F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

### **3.10 SUBSTATION GROUNDING**

- A. Provide an underground fence ground conductor, minimum 1/0 copper buried 18", located 3 feet outside the fence perimeter. Bond the fence ground grid into the substation ground grid. Ground fence at each side of gate or other openings. Gates shall be bonded to the grounding conductor, with a jumper to the gate. A buried bonding jumper shall be used across the gate or other openings. Provide an underground grounding conductor under the gate swing area. Barbed wire strands used above the fence fabric shall be bonded to the grounding conductor, jumper or fence. Fence posts shall be connected to the grounding conductor with suitable connecting means. Ground all corner posts and line post every 50 feet.
- B. Provide a substation underground ground grid of 4/0 bare stranded copper cable buried 18" below grade in a minimum 10' by 20' grid. Exothermic weld connections of 4/0 cables at all junctions.
- C. Provide grounding conductor for the grounded neutral for transformers, reactors and capacitors. Provide grounding conductor for lighting arrestors, gaps and similar devices. Provide grounding for all exposed metal parts of switches, structures, transformer tanks, metal walkway, steelwork of buildings, switchboards, instrument-transformer secondaries, etc.
- D. Provide two ground rods/chemical electrodes, or as shown on drawings. Connect to underground grounding conductor.

### **3.11 FIELD QUALITY CONTROL**

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
  - 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
  - 2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
  - 3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
  - 4. Testing: Perform the following field quality-control testing:
    - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

- b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
- c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
  - 1) Equipment Rated 500 kVA and Less: 10 ohms.
  - 2) Equipment Rated 500 to 1000 kVA: 5 ohms.
  - 3) Equipment Rated More Than 1000 kVA: 3 ohms.
  - 4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
  - 5) Manhole Grounds: 10 ohms.
- d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

### **3.12 GRADING AND PLANTING**

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION 260526

**SECTION 260527 - SUPPORTING DEVICES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Conduit and Equipment Supports
- B. Fastening Hardware
- C. Concrete Housekeeping Pads
- D. Foundation and Underground Sleeves and Seals

**1.2 QUALITY ASSURANCE**

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

**1.3 COORDINATION**

- A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners
- F. Orbit Industries

**2.2 MATERIAL**

- A. Support Channel: Hot-dip galvanized stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.
- C. Anchorage and Structural Attachment Components:
  - 1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.

- a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
  2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
  3. Welding Lugs: Comply with MSS-SP-69, Type 57.
  4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangers. Single-sided type is not acceptable.
  5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
  6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
  7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
  8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
- D. Conduit Sleeves and Lintels:
1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
  2. Refer to Structural General Notes for lintel requirements in masonry construction.
  3. Refer to Structural plans and specifications for lintel requirements and sizes.
  4. Lintels:
    - a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
    - b. All lintels shall have a minimum of 8" end bearing.
    - c. All lintels in exterior wall construction shall be hot-dip galvanized.
    - d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
      - 1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
      - 2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
      - 3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (Ilv)
      - 4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (Ilv)
    - e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.
  5. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
  6. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.

7. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
8. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
9. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
10. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
11. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
12. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:
  - a. Anvil International HBS-Base Series
  - b. Cooper B-Line Dura-Blok
  - c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

G. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.



- b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

## 2.3 FOUNDATION - UNDERGROUND SLEEVES AND SEALS

### A. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, raceways passing through foundation walls to an underground condition shall have their annular space (sleeve or drilled hole "" not tapered hole made with knockout plug) sealed by properly sized sealing element consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve.
3. Sleeves shall be at least 2 trade sizes larger than the penetrating raceway.
4. Pressure shall be maintained by stainless steel bolts and accessories. Pressure plates may be of composite materials for Models S and OS.
5. Sealing Elements shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant / Stainless	Nitrile	-40°F to 210°F

6. Approved Manufacturers:
  - a. Thunderline Corporation "Link-Seals"
  - b. O-Z/Gedney Company
  - c. Calpico, Inc
  - d. Innerlynx

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

- D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- E. Do not use powder-actuated anchors without specific permission.
- F. Do not drill structural steel members.
- G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.
- I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.
- J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- L. Refer to Section 260533 for special conduit supporting requirements.

### **3.2 FINISH**

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
- B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION 260527

**SECTION 260533 - CONDUIT AND BOXES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Rigid metallic conduit and fittings (RMC)
- B. Stainless steel conduit (316SS) and fittings
- C. Intermediate metallic conduit and fittings (IMC)
- D. Electrical metallic tubing and fittings (EMT)
- E. Flexible metallic conduit and fittings (FMC)
- F. Liquidtight flexible metallic conduit and fittings (LFMC)
- G. Rigid polyvinyl chloride conduit and fittings (PVC)
- H. High density polyethylene conduit and fittings (HDPE)
- I. Reinforced thermosetting resin conduit (RTRC)
- J. Phenolic reinforced thermosetting resin conduit (Phenolic RTRC)
- K. Wall and ceiling outlet boxes
- L. Electrical connection
- M. Pull and junction boxes
- N. Handholes
- O. Accessories

**1.2 RELATED WORK**

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

**1.3 REFERENCES**

- A. American National Standards Institute (ANSI):
  1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
  2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
  3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
  4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
  5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
  6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

- B. Federal Specifications (FS):
  - 1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
  - 2. A-A-55810 - Specification for Flexible Metal Conduit
- C. NECA "Standards of Installation"
- D. National Electrical Manufacturers Association (NEMA):
  - 1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
  - 2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
  - 3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
  - 4. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation
- E. NFPA 70 - National Electrical Code (NEC)
- F. Underwriters Laboratories (UL): Applicable Listings
  - 1. UL 1 - Flexible Metal Conduit
  - 2. UL 6 - Rigid Metal Conduit
  - 3. UL 360 - Liquid Tight Flexible Steel Conduit
  - 4. UL514-B - Conduit Tubing and Cable Fittings
  - 5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
  - 6. UL651-B - Continuous Length HDPE Conduit
  - 7. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
  - 8. UL797 - Electrical Metal Tubing
  - 9. UL1242 - Intermediate Metal Conduit
- G. American Standard of Testing and Materials (ASTM):
  - 1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
  - 2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
  - 3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
  - 4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
  - 5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
  - 6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material
- H. Definitions:
  - 1. Fittings: Conduit connection or coupling.
  - 2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
  - 3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
  - 4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.

5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

#### 1.4 SUBMITTALS

- A. Include fittings and conduits 1.5" and larger in coordination files. Include all in-floor and underfloor conduit in coordination files. Refer to Section 260500 for coordination drawing requirements.

### PART 2 - PRODUCTS

#### 2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

- A. Manufacturers:
  1. Allied
  2. LTV
  3. Steelduct
  4. Calbond Calpipe
  5. Wheatland Tube Co
  6. O-Z Gedney
  7. or approved equal.
  
- B. Manufacturers of RMC Conduit Fittings:
  1. Appleton Electric
  2. O-Z/Gedney Co.
  3. Electroline
  4. Raco
  5. Bridgeport
  6. Midwest
  7. Regal
  8. Thomas & Betts
  9. Crouse-Hinds
  10. Killark
  11. Orbit Industries
  12. or approved equal.
  
- C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.
  
- D. Fittings and Conduit Bodies:
  1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
  2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
  3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
  5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
- E. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system.
1. Acceptable Manufacturers:
    - a. Calbond Calpipe
    - b. Robroy
    - c. T&B Ocal
    - d. or approved equal.

## 2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.
- B. Manufacturers:
1. Allied
  2. LTV
  3. Steelduct
  4. Wheatland Tube Co
  5. O-Z Gedney
  6. or approved equal.
- C. Fittings and Conduit Bodies:
1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
  2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
  3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
  4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
  5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

## 2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied
2. Calbond Calpipe
3. LTV
4. Steelduct
5. Wheatland Tube Co
6. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
  - a. Appleton Electric
  - b. O-Z/Gedney Co.
  - c. Electroline
  - d. Raco
  - e. Bridgeport
  - f. Midwest
  - g. Regal
  - h. Thomas & Betts
  - i. Orbit Industries
  - j. or approved equal.

## 2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.

B. Manufacturers:

1. American Flex
2. Alflex
3. Electri-Flex Co
4. or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:

1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
  - a. O-Z/Gedney Co.

- b. Thomas & Betts
- c. Appleton Electric
- d. Electroline
- e. Bridgeport
- f. Midwest
- g. Regal
- h. Orbit Industries
- i. or approved equal.

## 2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

### A. Manufacturers:

- 1. Anaconda Type UA
- 2. Electri-Flex Type LA
- 3. Alfalex
- 4. Carlon (Lamson & Sessions)
- 5. or approved equal.

### B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

### C. Fittings and Conduit Bodies:

- 1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
- 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
- 3. Manufacturers:
  - a. Appleton Electric
  - b. O-Z/Gedney Co.
  - c. Electroline
  - d. Bridgeport
  - e. Thomas & Betts
  - f. Midwest
  - g. Regal
  - h. Carlon (Lamson & Sessions)
  - i. Orbit Industries
  - j. or approved equal.

## 2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

### A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

### B. Acceptable Manufacturers:

- 1. Carlon (Lamson & Sessions) Type 40
- 2. Cantex, J.M. Mfg.
- 3. or approved equal.

### C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.



- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

## 2.7 HIGH DENSITY POLYETHYLENE (HDPE)

- A. Minimum Size: 2 inch, unless noted otherwise.
- B. Acceptable Manufacturers:
  1. Carlon
  2. Chevron Phillips Chemical Company
  3. or approved equal.
- C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	less than 0.941
D-1238	Melt Index, g/10 min Condition E	greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	less than 80,000
D-746	Brittleness Temperature	-75°C Max

- D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
- E. Fitting and Conduit Bodies:
  1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
  2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
  3. E-loc type couplings are not acceptable in any situations.
  4. Acceptable Manufacturers:
    - a. ARCON
    - b. Carlon
    - c. or approved equal.

## 2.8 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC) AND FITTINGS

- A. Minimum Size: 1 inch.
- B. Acceptable Manufacturers:
  1. Champion Fiberglass

2. Atkore - FRE Composites
  3. or approved equal.
- C. Conduit shall be fiberglass reinforced epoxy using a filament winding process. Conduit, elbows and fittings shall be manufactured from the same resin/hardener/glass system and the same filament wound system. Resin systems shall be epoxy with no fillers. Glass used shall be E-type.
- D. Fitting and Conduit Bodies:
1. Expansion fittings for RTRC shall be provided in accordance with Electrical Code.
  2. Joints in wet locations and underground locations shall be watertight.

## **2.9 PHENOLIC REINFORCED THERMOSETTING RESIN CONDUIT AND FITTINGS (PHENOLIC RTRC)**

- A. Minimum Size: 1 inch.
- B. Manufacturers:
1. Champion Fiberglass Flameshield XW
  2. Atkore - FRE Composites BreathSaver
  3. or approved equal.
- C. Conduit shall be low smoke, no flame, low toxicity. Conduit shall be fiberglass reinforced phenolic using a filament winding process. Conduit, elbows, conduit bodies, and fittings shall be manufactured from the same resin/hardener/glass system and the same filament wound system. Resin systems shall be phenol with no fillers. Fiberglass used shall be E-type.
- D. Fitting and Conduit Bodies:
1. Expansion fittings shall be provided in accordance with Electrical Code.
  2. Joints in wet locations and underground locations shall be watertight.

## **2.10 OUTLET BOXES**

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast ferrous alloy, or stainless steel deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
- E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

- F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

## **2.11 ECONN; ELECTRICAL CONNECTION**

- A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

## **2.12 JB; PULL AND JUNCTION BOXES**

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

## **2.13 HANDHOLES**

- A. HH; Handhole, composite polymer concrete body and cover. Stainless steel hardware. Bolted non-skid cover rated for 10,000 pounds. Design load occasional non-deliberate vehicular traffic. Stack units to achieve depth shown on plans. Units in landscaped areas shall be green in color. 11"W, 18"L, 18"D or dimensions as shown on plans.
  - 1. Manufacturers:
    - a. Hubbell/Quazite PG#####BB18, PG#####HA00
    - b. Carson Industries H Series
    - c. Armorcast
    - d. Highline Products
    - e. Synertech
- B. HH; Handhole, cast iron, hot dipped galvanized with checkered cover sidewalk weatherproof box, flat neoprene cover gasket. Stainless steel screw hardware. Mounted flush in concrete. 12"W, 18"L, 12"D or dimensions as shown on plans.
  - 1. Manufacturers:
    - a. Appleton Electric WYT Series, WYT 181212

- b. OZ Gedney YT Series
- c. Crouse Hinds WJBF Series

## 2.14 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control - IsoBacker Pad, SpecSeal - SSP Putty and Pads, 3M #MPP-4S or equal.
- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control - SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION TRAINING

- A. PVC coated rigid metal conduit, phenolic reinforced thermosetting resin conduit (phenolic RTRC), and reinforced thermosetting resin conduit (RTRC) manufacturers shall provide Contractor installation training for field cutting, joint preparation, joint assembly, field bending, and field cut sealing.

### 3.2 CONDUIT INSTALLATION SCHEDULE AND SIZING

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.
- B. Installation Schedule: Refer to drawings.
- C. Fire Rated Assemblies:
  - 1. Listed Fire Rated Assemblies: Phenolic RTRC
- D. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- E. Minimum Conduit Size (Unless Noted Otherwise):
  - 1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
  - 2. Below Grade 5' or less from Building Foundation: 1 inch.
  - 3. Below Grade More than 5' from Building Foundation: 1 inch.
  - 4. Telecommunication Conduit: 1 inch.
  - 5. Controls Conduit: 3/4 inch.

- F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

### **3.3 CONDUIT ARRANGEMENT**

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):
  1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
  2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.
- D. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

### **3.4 CONDUIT SUPPORT**

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
  1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

### 3.5 CONDUIT INSTALLATION

#### A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

#### B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

#### C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
  - a. A third bend is acceptable if:
    - 1) The total run is not longer than (33) feet.
    - 2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

## D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal; refer to Section 260503 for through penetration firestopping requirements.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade
  - a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
  - b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
  - c. No conduits are allowed to be routed horizontally through slabs above grade.
10. Do not route conduits across each other in slabs on grade.
11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.



15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

### **3.6 CONDUIT TERMINATIONS**

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

### **3.7 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) OVERHEAD CONDUIT INSTALLATION**

- A. Conduit shall be installed away from high temperature piping and equipment.
- B. Conduit shall be installed to prevent exposure to ultraviolet radiation.
- C. Proper allowances shall be made for expansion and/or contraction of the conduit during installation.
- D. Expansion fittings shall be installed in any 100' continuous run of conduit and at each 100' thereafter.

- E. Supports shall be made from non-corroding materials and spacing shall not be greater than the listing in the Electrical Code, but also shall not exceed the manufacturer's recommendations depending on the expected surface temperature.

### 3.8 UNDERGROUND CONDUIT INSTALLATION

#### A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

#### B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

#### C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.

- D. Expansion Fittings at Finished Grade: Provide underground raceways with an expansion fitting after emerging from finished grade and exterior equipment pads. Field locate the expansion fitting above and within 24 inches of finished grade. Raceways extending less than 12 inches above finished grade, transitioning to FLMC within 12 inches of finished grade, and interior concrete building slabs do not require an expansion fitting unless required by code.

#### E. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum  $f'c = 2500$  and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

F. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

G. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).
3. Duct Seal Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSEI).

a. Manufacturers:

- 1) Raychem Rayflate Duct Sealing Systems RDSS
- 2) Approved equal

### 3.9 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

### 3.10 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

### 3.11 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

### **3.12 PULL AND JUNCTION BOX INSTALLATION**

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

### **3.13 EXPOSED BOX INSTALLATION**

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION 260533

**SECTION 260542 - EQUIPMENT WIRING SYSTEMS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Electrical connections to equipment specified under other Sections or furnished by the Owner.

**1.2 REFERENCES**

- A. NEMA WD 1 - General Purpose Wiring Devices
- B. NEMA WD 6 - Wiring Device Configurations
- C. NFPA 70 - National Electrical Code (NEC)

**PART 2 - PRODUCTS****2.1 CORDS AND CAPS**

- A. Straight-blade Attachment Plug: NEMA WD 1.
- B. Locking-blade Attachment Plug: NEMA WD 5.
- C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: Oil-resistant thermoset insulated Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.
- E. Cord Size: Suitable for connected load of equipment and rating of branch circuit over-current protection.

**PART 3 - EXECUTION****3.1 INSPECTION**

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

**3.2 PREPARATION**

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

**3.3 INSTALLATION**

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

- B. Make cord connections to equipment using flexible conduit. Use liquidtight flexible conduit in damp or wet locations.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
- G. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

### **3.4 EQUIPMENT CONNECTION SCHEDULE**

- A. Uninterruptible Power Supply (UPS).
- B. Powered Furniture in Radio Room.
- C. Antenna Tower.

END OF SECTION 260542



## **SECTION 260553 - ELECTRICAL IDENTIFICATION**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Adhesive Markings and Field Labels
- B. Nameplates and Signs
- C. Product Colors

#### **1.2 REFERENCES**

- A. NFPA 70E - National Electrical Safety Code
- B. NFPA 70 - National Electrical Code (NEC)
- C. ANSI A13.1 - Standard for Pipe Identification
- D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

#### **1.3 QUALITY ASSURANCE**

- A. Electrical identification products shall be suitable for the environment installed. Identification labels damaged by the environment due to ultraviolet light fading, damp or wet conditions, physical damage, corrosion, or other conditions shall be replaced with labels suitable for the environment.

#### **1.4 SUBMITTALS**

- A. General: Submit the following in accordance with Division 1 Specification Sections and under provisions of Section 260500.
  - 1. Product Data for each type of product specified.
  - 2. Schedule of nomenclature to be used for identification signs and labels for each piece of equipment including, but not limited to, the following equipment types as specified in Division 26.
  - 3. Samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.
  - 4. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 21/22/23.

### **PART 2 - PRODUCTS**

#### **2.1 ADHESIVE MARKINGS AND FIELD LABELS**

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:
    - a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).
  2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.
- F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Brass or Aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch metal tags with stamped legend, punched for fastener.
- I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
- J. Text Sizes:
1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
    - a. Font: Normal 721 Swiss Bold
    - b. Adhesive Labels: 3/16 inch minimum text height
    - c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

## 2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.

- B. Text Sizes:
  - 1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
    - a. Text Height: 3/8 inch minimum
- C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

### 2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
  - 1. Normal Power and General Labels: Black letters on white face
  - 2. Control Labels: Black letters on white face
  - 3. Medium Voltage (greater than 1,000 volts): Black letters on white face
  - 4. Fire Alarm: Red letters on white face
  - 5. Emergency: Red letters on white face
- B. Nameplates and Signs:
  - 1. NORMAL POWER: Black letters on white face
  - 2. Control Labels: Black letters on white face
  - 3. EMERGENCY: White letters on red face
  - 4. GROUNDING: White letters on green face.
  - 5. CAUTION or UPS: Black letters on yellow face
- C. Raceways and Conduit:
  - 1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
    - a. Normal Power and General Distribution: Silver
    - b. Emergency Power Distribution System:
      - 1) All Emergency: Orange
      - 2) Legally Required Standby: Yellow
      - 3) Optional Standby: Orange
      - 4) Life Safety and Critical Branch: Yellow
      - 5) Equipment Branch: Orange
    - c. Fire Alarm System: Red
    - d. Temperature Controls: Refer to mechanical cover sheet for color
    - e. Ground: Green

- f. Low Voltage and Telephone: Purple
- g. Clock, Sound, Security System, and Intercom: Black

D. Box Covers:

1. Box covers shall be painted to correspond with system type as follows:

- a. Normal Power and General: Silver
- b. Emergency Power and Distribution:
  - 1) All Emergency: Orange
  - 2) Legally Required Standby: Yellow
  - 3) Optional Standby: Orange
  - 4) Life Safety and Critical Branch: Yellow
  - 5) Equipment Branch: Orange
- c. Fire Alarm System: Red
- d. Temperature Controls: Refer to mechanical cover sheet for color
- e. Ground: Green
- f. Low Voltage and Telephone: Purple
- g. Clock, Sound, Security System, and Intercom: Black

2. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the A/E prior to installation and ordering of materials.
- C. Electrical System Color Chart: This Contractor shall furnish and install framed 8" x 12" charts of the color-coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.
- D. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.
- E. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

- F. Circuit Identification: Tag or label conductors as follows:
1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
  2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
  3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- G. Apply Danger, Warning, Caution and instruction signs as follows:
1. Install Danger, Warning, Caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
  2. 'Danger' indicates a hazardous situation which, if not avoided, will result in death or serious injury. ANSI standard red background, white letters.
  3. 'Warning' indicates a hazardous situation which, if not avoided, could result in death or serious injury. ANSI standard orange background, black letters.
  4. 'Caution' indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. ANSI standard yellow background, black letters.
  5. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- H. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- I. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- J. Install ARC FLASH WARNING signs on all power distribution equipment per Section 260573.
- K. Install ARC FLASH WARNING signs on all switchboards, switchgear, distribution panels, branch panelboards, industrial control panels, and motor control centers.
1. Sample Label:  
  
! WARNING  
ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED  
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY  
REFER TO NFPA 70E

- L. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.
  - 1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to conduits concealed within wall.
  - 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.
- M. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:
  - 1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.
- N. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

### 3.2 FEEDER AND BRANCH CIRCUIT DIRECTORIES

- A. Product:
  - 1. Adhesive labels and field markings
  - 2. Nameplates and signs
- B. Feeder Directories Branch: Provide each feeder, branch circuit, feeder modification, and branch circuit modification with a typed circuit directory label. Refer to technical equipment specification sections for additional requirements. Include the following with each label:
  - 1. Load Description: Lighting, receptacles, specific equipment, spare, space, or similar description.
  - 2. Location: Room name, number, location.
- C. Provide a factory or custom clear plastic sleeve for each branch panel directory and secure to inside panel cover.

### 3.3 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

- A. Product:
  - 1. Adhesive labels and field markings
  - 2. Nameplates and signs
- B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

- C. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.
- D. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.
- E. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24").

### **3.4 CONDUIT AND EXPOSED CABLE LABELING**

- A. Product:
  - 1. Adhesive labels and field markings
- B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 20 foot (6 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible, or separated by enclosures, walls, partitions, ceilings, and floors. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:
  - 1. Medium Voltage (greater than 1,000 volt): Indicate feeder identification and voltage.
  - 2. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
  - 3. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
  - 4. Fire Alarm: Indicate "FIRE ALARM".
  - 5. Grounding: Indicate "GROUND" and equipment and designation.
  - 6. Security System: Indicate "Security".
  - 7. Telephone System: Indicate "Telephone".
- C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

### **3.5 CONDUIT AND RACEWAY COLOR BANDING FOR EXISTING CONDITIONS AND REMODELING**

- A. Existing Conduit and Raceways: Identify existing conduits and raceways within the limits of the project boundary with color banding.
  - 1. Existing conduit and raceways to be color banded: 3/4 inch and larger.
  - 2. The Contractor shall perform a review of the existing conduit, raceway, and system type prior to submitting a bid. The Contractor's review shall include a review of areas with non-finished ceilings and areas with accessible finished ceilings.
- B. New Conduit and Raceways: Identify new conduits and raceways with color banding. The following products and materials shall be identified with color banding when required by Part 1 of this specification.
  - 1. Rigid metallic conduit and fittings (RMC)
  - 2. Intermediate metallic conduit and fittings (IMC)
  - 3. Reinforced thermosetting resin conduit (RTRC)
  - 4. Phenolic reinforced thermosetting resin conduit (phenolic RTRC conduit) Example: Fire-rated cable and assemblies

5. Wire and cable installed with or without raceways:
  - a. Fire-rated cable and assemblies (including but not limited to MI, fire-rated MC)
  - b. Healthcare facilities cable (HFC)
  - c. Armored cable (AC)
  - d. Metal-clad cable (MC)
  - e. Low voltage cabling

C. Instructions:

1. Band exposed or accessible raceways, cables, and bare conductors of the. Bands shall be pretensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Refer to Part 1 of this specification for specific systems and colors requiring banding.
2. Install bands at changes within 36 inches of direction changes, all wall/floor penetrations, at each junction box, and at 10-foot maximum intervals in straight runs.

### 3.6 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

### 3.7 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.
2. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.



- C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
- D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.
- E. Conductors shall be color coded as follows:
  - 1. 120/240 Volt, 3-Wire:
    - a. A-Phase - Black
    - b. B-Phase - Red
    - c. Neutral - White
    - d. Ground Bond - Green
  - 2. 208Y/120 Volt, 4-Wire:
    - a. A-Phase - Black
    - b. B-Phase - Red
    - c. C-Phase - Blue
    - d. Neutral - White
    - e. Ground Bond - Green
  - 3. 480Y/277 Volt, 4-Wire:
    - a. A-Phase - Brown
    - b. B-Phase - Orange
    - c. C-Phase - Yellow
    - d. Neutral - Gray
    - e. Ground Bond - Green
  - 4. 120 Volt, 2-Wire Isolated (Ungrounded) Power System:
    - a. A-Phase - Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    - b. B-Phase - Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    - c. Ground Reference - Green
  - 5. 120/208 Volt, 3-Wire, Isolated (Ungrounded) Power System:
    - a. A-Phase - Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    - b. B-Phase - Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    - c. C-Phase - Yellow with distinctive colored stripe other than white, green or gray along the entire length of the conductor
    - d. Ground Reference - Green

6. 0 to 1500 Volt, Direct Current DC Power System:
  - a. Ungrounded Positive Polarity: Red or black with permanent red stripe marked along the entire length. Provide shrink wrap sleeves at terminations indication (POS, POSITIVE, or POS (+).
  - b. Ungrounded Negative Polarity: Black. Provide shrink wrap sleeves at terminations indication (NEG, NEGATIVE, or NEG (-).
  - c. Grounded Conductor in Grounded DC systems (refer to paragraphs a and b above for marking of ungrounded conductors):
    - 1) When Positive Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at terminations indication (POS. POSITIVE, or POS (+).
    - 2) When Negative Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at termination indication (NEG, NEGATIVE, or NEG (-).
  
7. Grounding Conductors:
  - a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
  - b. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor. Isolated ground for feeders, use colored tape with alternating bands of green and yellow to provide a minimum of three bands of green and two bands of yellow.
  
8. Cabling for Remote Control, Signal, and Power Limited Circuits:
  - a. Fire Alarm: Refer to Fire Alarm and Automatic Detection Section 283100 for cable color requirements.
  - b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
  - c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
  - d. Nurse Call: Refer to Division 27.
  - e. Electronic Control: Per manufacturer recommendations and code requirements.
  - f. Audio/Visual Systems: Refer to Division 27.
  - g. Structured Cabling: Refer to Division 27.

### 3.8 CONTROL EQUIPMENT IDENTIFICATION

- A. Products:
  1. Nameplates and signs
  
- B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.
  
- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
  
- D. Labeling shall include:
  1. Equipment type and contract documents designation of equipment being served.
  2. Location of equipment being served if it is not located within sight.
  3. Voltage and phase of circuit(s).
  4. Panel and circuit number(s) serving the equipment.

5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
7. Date of fault current study, refer to one-line diagram
8. Sample Label:

EXHAUST FAN EF-1 ("LOCATED ON ROOF")  
 480V, 3-PHASE  
 FED FROM "1HA1-1"  
 AUTO CONTROL BY FMCS  
 22,000 AMPS AVAILABLE FAULT CURRENT  
 DATE OF STUDY: 1 JAN 2017

### 3.9 EQUIPMENT CONNECTION IDENTIFICATION

- A. Products:
  1. Nameplates and signs
- B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.
- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:
  1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handing ventilation units, condensing units, unit heaters, and similar equipment
  2. Plumbing equipment
  3. Fire protection equipment including fire pumps
  4. Medical gas equipment and equipment skids
  5. Elevator
  6. Kitchen equipment (hardwired)
  7. Industrial machinery
  8. Owner-provided equipment including:
    - a. Powered Furniture in Radio Room.
    - b. Antenna Tower.
    - c. Uninterruptible Power Supply (UPS).
- D. Labeling shall include:
  1. Equipment type and contract documents designation of equipment being served
  2. Location of equipment being served if it is not located within sight.
  3. Voltage and rating of the equipment.
  4. Panel and circuit numbers(s) serving the equipment
  5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
  6. Date of fault current study; refer to one-line diagram

## 7. Sample Label:

UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")  
 480V: 3-PHASE  
 FED FROM "1HA1-1"  
 22,000 AMPS AVAILABLE FAULT CURRENT  
 DATE OF STUDY: 1 JAN 2017

**3.10 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION**

## A. Products:

## 1. Nameplates and signs

## B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:

- a. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Applicable equipment includes components of the life safety and critical branch for healthcare facilities (generators, transfer switches, switchboards, distribution panels, panelboards, etc.).
- b. Equipment type and contract documents designation of equipment.
- c. Voltage of the equipment.
- d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
- e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
- f. Sample Label:

DISTRIBUTION PANEL DP-H1  
 480Y/277V  
 FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

## 4. Provide the following on a separate label, installed below the label above:

- a. Available fault current; refer to one-line diagram or panel schedules
- b. Date of fault current study; refer to one-line diagram
- c. Sample Label:

22,000 AMPS AVAILABLE FAULT CURRENT  
 DATE OF STUDY: 1 JAN 2017

## C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:

1. Nominal system voltage, service wire size, quantity, material, distance
2. Maximum available fault current; refer to one-line diagram for values
3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 260573 for value.

4. Date of fault current study; refer to one-line diagram
5. Date of label
6. Sample Label:

480Y/277V, 6 SETS 4#750KCM CU, 75FT  
 39,800 AMPS AVAILABLE FAULT CURRENT  
 0.07 SECOND CLEARING TIME  
 DATE OF STUDY: 1 JAN 2017  
 DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
  - a. Label: "This equipment is designed with a system listed below".
  - b. Applicable Systems:
    - 1) Zone-selective interlocking system for selective coordination and arc energy reduction
    - 2) Differential relaying system for selective coordination and arc energy reduction
    - 3) Arc energy reducing maintenance switch
    - 4) Energy reducing active arc flash mitigation system

E. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.
  - a. Label:
    - 1) Long-time delay:
    - 2) Long-time pickup:
    - 3) Short-time delay:
    - 4) Short-time pickup:
    - 5) Instantaneous:
    - 6) Ground fault delay:
    - 7) Ground fault:
  - b. Sample Label:
 

Long-time delay: 10.0  
 Long-time pickup: 1.0  
 Short-time delay: 0.15  
 Short-time pickup: 5.0  
 Instantaneous: 2.0  
 Ground fault delay: 0.25  
 Ground fault: 50.0

- F. Nominal System Voltage Label:
1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.
- G. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.
1. Sample Labels for Feeders:
    - 4#3/0 CU & 1#6 CU GND, 125FT
    - 4#250KCM AL & 1#6 GND CU, 125FT
    - 2 SETS 4#400KCM CU & 1#1 GND CU, 125FT
- H. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 260500 for other requirements.

### 3.11 INDUSTRIAL CONTROL PANEL IDENTIFICATION

- A. Products:
1. Nameplates and signs
- B. Provide identification on the front of all industrial control panels and similar equipment. Labels shall be visible on the exterior of the gear and correspond to the one-line and/or schematic diagram nomenclature.
1. Interior equipment: The identification material shall be engraved plastic-laminated labels.
  2. Labeling shall include:
    - a. Equipment type and contract documents designation of equipment.
    - b. Manufacturer / Assembler of industrial control panel
    - c. Voltage, phase, frequency, full load current of each supply circuit
    - d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
    - e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
    - f. Sample Label:
      - INDUSTRIAL CONTROL PANEL ICP-1
      - ABC COMPANY
      - 480V, 3PHASE, 60HZ, 60A (PANEL E1-1 LOCATED IN ELEC 123)
      - 120V, 1PHASE, 60HZ, 20A (PANEL E2-1 LOCATED IN ELEC 123)
      - 22,000 SHORT CIRCUIT RATING

- C. Nominal System Voltage Label:
  - 1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used shall be permanently posted on the interior of the door or cover of the industrial control panel.
- D. Schematic Diagram: Provide a laminated copy of the industrial control panel schematic wiring diagram. Post the diagram on the inside cover of the control panel.
- E. Service Equipment Label: Refer to Electrical Distribution Equipment - Service Equipment Label of this specification if applicable for additional requirements.

### **3.12 TRANSFORMER EQUIPMENT IDENTIFICATION**

- A. Products:
  - 1. Nameplates and signs
- B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.
- C. Labeling shall include:
  - 1. Equipment type and contract documents designation of equipment
  - 2. Name of the upstream equipment.
  - 3. Voltage and rating of the equipment.
  - 4. Location of the upstream equipment if it is not located within sight.
  - 5. Sample Label:
 

TRANSFORMER TR-15  
480V: 208Y/120V 15KVA  
FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

### **3.13 DC VOLTAGE EQUIPMENT IDENTIFICATION**

- A. Products:
  - 1. Names and signs
- B. Provide identification on the front of all DC voltage equipment, storage batteries, disconnects. The identification nameplate shall be engraved plastic-laminate label.
- C. Label shall include:
  - 1. Equipment type and contract documents designation of equipment.
  - 2. Name of upstream equipment and location of the upstream equipment if it is not located within sight.
  - 3. Nominal equipment voltage and rating.
  - 4. Available fault current (from batteries if applicable).
  - 5. Date of fault current study; refer to one-line diagram.

## 6. Sample Label:

STORAGE BATTERY SB-1  
 600 VOLT DC, 50 KVA  
 39,800 AMPS AVAILABLE FAULT CURRENT  
 DATE OF STUDY: 1 JAN 2017

**3.14 ELECTRICAL WORKING CLEARANCE IDENTIFICATION**

## A. Products:

1. Safety Yellow paint and custom stencils

## B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

## C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

**3.15 SERIES RATING IDENTIFICATION**

## A. Products:

1. Nameplates and signs

## B. Upstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - IDENTICAL COMPONENT REPLACEMENT REQUIRED".

## C. Downstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - ADDITIONAL SERIES COMBINATION RATING: XX,XXX RMS SYMMETRICAL AMPERES" where XX,XXX shall be the series combination rating.

**3.16 POLE IDENTIFICATION**

## A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

## B. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" (610mm) above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

END OF SECTION 260553



**SECTION 260573 - POWER SYSTEM STUDY****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Low voltage distribution system power study.
- B. Short-circuit analysis and report.
- C. Selective coordination analysis and report.
- D. Arc-flash hazard analysis and report.

**1.2 RELATED SECTIONS**

- A. Section 260500 - Basic Electrical Requirements
- B. Section 262413 - Switchboards
- C. Section 262416 - Panelboards
- D. Section 263213 - Packaged Engine Generator Systems
- E. Section 263600 - Transfer Switch

**1.3 QUALITY ASSURANCE**

- A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections.

**1.4 SUBMITTALS**

- A. Documentation shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.
- B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.
- C. Documentation of the analyses shall be submitted in a single bound electronic (PDF or equal) format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. The submittal of these related specification sections will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.
- D. Power system study project model shall be submitted on electronic media for review and the Owner's operating and maintenance records.

**1.5 REFERENCES**

- A. NFPA 70 - National Electrical Code (NEC)

- B. CEC California Electrical Code
- C. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations, latest version
- D. ANSI Z535.4 - Products Safety Signs and Labels

## **1.6 SCOPE**

- A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.
- B. Contractor is required to provide a fully coordinated system for the emergency electrical system or essential electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

## **PART 2 - PRODUCTS**

### **2.1 POWER SYSTEM STUDY**

- A. Power systems study shall be completed in Power Tools for Windows (PTW) version 9 or later version or pre-approved equivalent program.
- B. Power system studies including, but not limited to short-circuit analysis, selective coordination, and arc-flash analysis are inherently iterative in nature. The initial and subsequent analysis commonly requires engineering evaluation, equipment modification, setting adjustments, and revised analysis report. The power system analysis scope shall not be considered complete until all outstanding engineering, equipment and device setting solutions have been resolved and documented by a final report. The power system study vendor shall provide inclusive bid provisions for the initial, subsequent, final analysis and associated reports.

## **PART 3 - EXECUTION**

### **3.1 SHORT-CIRCUIT ANALYSIS**

- A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.
- B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.
- C. Short-circuit analysis documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted and made available to the AHJ if requested.

### **3.2 SELECTIVE COORDINATION ANALYSIS**

- A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

- B. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.1 second.
- C. Existing Distribution, Selective Coordination, and Analysis:
1. The scope of work includes modification, replacement, adjustments, or additions of the emergency distribution system. A complete analysis and evaluation of the existing Emergency and Legally required branches is required in addition to the evaluation and analysis of the new distribution system components.
  2. The contractor shall provide field investigation service to collect all pertinent information required for a complete analysis and evaluation including but not limited to:
    - a. Over Current Protection Device (OCPD): Manufacturer, model, ratings, and settings.
    - b. Feeder and Branch Circuit Conductor: Wire gauge sizes, lengths, and material type
    - c. Transformers: Manufacturer, model, transformer KVA, impedance, phase, voltage, configuration.
    - d. Transfer Switch: Manufacturer, model, transfer switch voltage, amp rating, 3 or 4 pole configurations, switch style, short circuit withstand current rating.
    - e. Emergency Power Supply: Manufacturer, model, power source type, voltage, amperage, ratings, fault current contribution values.
    - f. Existing Distribution System Documentation: One line or riser diagram relationship of all distribution equipment including switchboards, switchgear, distribution panels, branch panelboards, transformers, transfer switches, emergency power supply, all line side normal and emergency power systems serving the applicable branches from the main electrical service and emergency power supply to the final branch circuit over current protection device.
- D. Provide trip settings for all (selectively coordinated and non-selectively coordinated) adjustable trip over current protection devices including long time delay, long time pickup, short time delay, short time pickup, instantaneous and ground fault. Selectively coordinated branches shall be based on the selective coordination study results. Non-selective coordinated branches shall be based on the design trip ratings. Provide selective coordination between all ground fault trip settings.
- E. The analysis shall include primary protective device, secondary main switchboard/switchgear device(s), switchboard/switchgear branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.
- F. The analysis shall include all normal, legally required, and optional standby overcurrent protection devices served by the same electrical bus and directly in parallel with the emergency branch requiring selective coordination.
- G. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.
1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.

2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.
  3. Each primary protective device required for the transformer shall be selected so the characteristics or operating band is within the transformer parameters, which shall include a parameter equivalent to 58% of the withstand point to afford protection for secondary line-to-ground faults. The transformer damage curve shall be included for the transformer when the selected protective device is not within the associated parameters.
  4. Molded case circuit breakers shall be separated from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.
  5. Include zone selective interlocking, differential relaying, and other selective coordination technology in the study when required by other specification sections.
  6. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
  7. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
    - a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.
- H. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

### 3.3 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.
- C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm<sup>2</sup>.
- D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

- F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
  2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- H. Include Arc Energy Reduction (AER) analysis in the study when required by other specification sections.
- I. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.
- J. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.
- M. Labels shall be vinyl or laminated, with a self-adhesive backing, conform with ANSI Z535.4 Products Safety Signs and Labels standard, and include the following:
1. Arc flash boundary
  2. Available incident energy calculated in the analysis and the corresponding working distance, or the arc flash personal protective equipment (PPE category) for the equipment, but not both.
- N. Examples showing the minimum required information follow:
- O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

**3.4 ADJUSTMENTS**

- A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study. Apply settings prior to placing equipment into operation. When the scope of work or execution includes remodel or phases construction, the contractor shall adjust applicable settings as required prior to each system component placed in operation.
- B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. greater than 8 cal/cm<sup>2</sup>), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

**3.5 TRAINING**

- A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION 260573

**SECTION 260916 - ELECTRICAL CONTROLS AND RELAYS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Relays and Timers
- B. Pushbutton Operators
- C. Control Power Cabinets

**PART 2 - PRODUCTS****2.1 CONTROL RELAYS**

- A. Mount relays in separate NEMA 1 enclosure or in control terminal cabinet.
- B. R-; General Purpose Relay:
  - 1. 120 volt continuous duty coil, 1 N.O. and 1 N.C. contacts, electrically held, 12-amp, 240 volt rated contacts. Provide compatible plug-in base socket.
  - 2. Manufacturers:
    - a. Square D Class 8501 Type K
    - b. Eaton
    - c. ABB
    - d. Siemens

**2.2 TIME RELAYS**

- A. R-; Time relays: shall be rated and shall be electric type incorporating mode of interval repeat cycle. Time period shall be adjustable.
- B. Time relays shall be mounted in NEMA 1 enclosures in control terminal cabinet.
- C. Manufacturers:
  - 1. Square D Class 9050 Type RE7
  - 2. Eaton
  - 3. ABB
  - 4. Siemens

**2.3 CONTROL POWER CABINET (CPC)**

- A. Provide a 12"x8"x4" screw cover NEMA 1 enclosure, single pole specification grade 20-amp switch in a single gang box, fuse block, fuses and equipment for interface of temperature control system. Mount above accessible ceiling.
- B. Manufacturers:
  - 1. Enclosure - Hoffman A-SE12X8X4, Weigmann, Hammond Manufacturing

2. Fuseholders - Bussman NDNLDF-WH, Mersen, Littelfuse
3. Neutral Block - Bussman NDNV4-WH, Mersen, Littelfuse

#### **2.4 CONTROL POWER CABINET (CPC)**

- A. 500 VA power supply with 5 isolated 24 VAC 100 VA Class II secondaries. 480/277/240/120 VAC primary. Secondary circuit breakers, manual switch and indicator light. 12"x12"x6" screw cover NEMA 1 steel enclosure. Equipment for interface of temperature control system. Mount above accessible ceiling.
  1. Manufacturers:
    - a. Functional Devices, Inc. PSH500A.

#### **2.5 EMERGENCY POWER OFF (EPO)**

- A. Mushroom head, (1) N.O. (1) N.C. contacts, 120 volt, turn to release, provide engraved nameplate. Provide guarded enclosure cover to protect from accidental operation. Parallel wire all EPO in suite when applicable.
  1. Provide engraved nameplate: EMERGENCY OFF.
  2. Manufacturers:
    - a. Square D 9001 XB5AS8445- KYG1Y
    - b. Eaton
    - c. ABB
    - d. Siemens 52PA2W2A

#### **2.6 LAMP ANNUNCIATOR (FA-LA)**

- A. Four indicators across and one indicator down. Surface mount, 125 volt. Supply with lamp test, lamp reset, and acknowledge buttons. Provide with 1/4" character height.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Coordinate with Mechanical Division 23 in connection of control conduit into control terminal cabinet.
- B. Install line voltage thermostats for single phase motors. Provided by Division 21/22/23.
- C. Provide remote control connection to remote devices.

END OF SECTION 260916



**SECTION 260933 - LIGHTING CONTROL SYSTEMS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Line and low voltage standalone lighting controls
- B. Automatic load control relay (ALCR3)
- C. Automatic load control relay (ALCR20)
- D. Distributed lighting control
- E. Central lighting controls
- F. Digital addressable lighting interface (DALI)
- G. Architectural dimmer rack and accessories
- H. Time switches

**1.2 RELATED SECTIONS**

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
  - 1. 26 51 19 LED Lighting
  - 2. Electrical Drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

**1.3 RELATED WORK**

- A. Section 230900 - Controls
- B. Section 265119 – LED Lighting

**1.4 QUALITY ASSURANCE**

- A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. All components and assemblies are to be factory pre-tested prior to delivery and installation.
- C. Comply with Electrical Code as applicable to electrical wiring work.

- D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
- E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.
- F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

## **1.5 REFERENCES**

- A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference
- B. FS W S 896 Switch, Toggle
- C. NEMA WD 1 - General Color Requirements for Wiring Devices
- D. NEMA WD 7 - Occupancy Motion Sensors
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL Standard 916 Energy Management Equipment
- G. UL 924 - Emergency Lighting and Power Equipment
- H. UL 1472 - Solid-State Dimming Controls

## **1.6 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements.
- C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.
- D. Submit a list of devices and equipment that will be installed for each sequence of operation.
- E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, dimmer panels, relay panels, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.
- F. Coordinate integration with mechanical and/or other trades.
- G. Verify acceptance of communications connection to building automation system. Submit BACnet IP parameters.

**1.7 EXTRA STOCK**

- A. Provide extra stock under provisions of Section 260500.
- B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.
- C. Relays and Dimmer Modules: Five (5) percent of quantity installed. Minimum of two (2) of each size and type.
- D. Control Stations: One (1) of each configuration and type, except for LCD touch screens requiring factory setup prior to installation.

**1.8 PROJECT RECORD DOCUMENTS**

- A. Submit project record documents under provisions of Section 260500.
- B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

**1.9 OPERATION AND MAINTENANCE DATA**

- A. Submit emergency, operation, and maintenance data under provisions of Section 260500. Data shall also include the following:
  - 1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
  - 2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
  - 3. Replacement part numbers for all system components.
- B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.
- C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

**1.10 SYSTEM DESCRIPTION**

- A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.
- B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.

1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.
  2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.
- C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.
1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.
  2. Distributed Control: Control equipment is in the space/zone being controlled; not reliant on centralized controllers.
    - a. All locations shall have the ability to be networked for remote control and monitoring, but network connections are not required.
  3. Centralized Control: Control equipment is in a central location serving multiple spaces/zones and provides time-based schedule and remote control.
    - a. The lighting control system (LCS) shall be networked with BACnet IP capabilities.
    - b. The lighting control system (LCS) shall have DMX512 capabilities.
  4. Digital Addressable Lighting Interface (DALI): DALI provides digital communications to each addressable ballast / driver or group. Lamp and device faults are sent to DALI server.
  5. Wireless Control: Equipment that uses radio frequency to transmit lighting control signals.

#### **1.11 MOCKUP**

- A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Approved luminaires and controls in mockup may be reused as part of complete work if in original condition.

#### **1.12 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.
- B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.
- C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1. A third-party Commissioning Agent will direct the commissioning process.

- D. The Contractor shall notify the Commissioning Agent, Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.
- E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.
- F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

### **1.13 WARRANTY**

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.
- B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 LIGHTING CONTROLS**

- A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.
- B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.
- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

### **2.2 LIGHTING CONTROL STATION**

- A. SW; The lighting control station shall contain the controls required by the lighting sequence of operation in a common coverplate. The controls may consist of switches, dimmers, occupancy sensors, pushbuttons, etc.
  1. In spaces where the wall control station is shown in multiple locations, the sequence of operation shall be the same at all locations, unless noted otherwise.
  2. The controls supplier shall prepare control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. The shop drawing submittal should be identified with the lighting sequence that the station provides. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

### **2.3 DEVICE COLOR**

- A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

## 2.4 COVERPLATES

- A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 260553.
- D. Plate-securing screws shall be metal with head color matching the wall plate finish.

## 2.5 WALL SWITCHES

- A. Refer to Electrical Symbols List for device type.
- B. Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Coverplate color shall match the switch color.
  - 1. Manufacturers:
    - a. Cooper 7621 CuVerro
    - b. Leviton A5621
  - 2. Install antimicrobial switches and cover plates in following departments:
    - a. ICU, NICU, OR, Cath Lab
- C. SW-1P; Single Pole Switch:
  - 1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
  - 2. Manufacturers:
    - a. Hubbell HBL1221
    - b. Leviton 1221-2
    - c. Pass & Seymour PS20AC1
    - d. Cooper AH1221
  - 3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
  - 4. Manufacturers:
    - a. Hubbell DS120
    - b. Leviton 5621
    - c. Pass & Seymour 2621
    - d. Cooper 7601.
- D. SW-1P-DJ; Push Button Door Jamb Switch:
  - 1. 120V 3A Single pole, momentary, metal pushbutton, with jamb box, and cover plate. Light on when door is open.
  - 2. Manufacturers:
    - a. Leviton 1865

- b. Pass & Seymour 1200
- c. Hubbell, Cooper

E. SW-3W; Three-way Switch:

1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
  - a. Hubbell 1223
  - b. Leviton 1223-2
  - c. Pass & Seymour PS20AC3
  - d. Cooper AH1223
3. 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:
  - a. Hubbell DS320
  - b. Leviton 5623
  - c. Pass & Seymour 2623
  - d. Cooper 7623

F. SW-4W; Four-way Switch:

1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
  - a. Hubbell 1224
  - b. Leviton 1224-2
  - c. Pass & Seymour PS20AC4
  - d. Cooper AH1224

## 2.6 WALL DIMMERS

- A. UL listed with integral air-gap switch for on/off control.
- B. Integral EMI/RFI suppression.
- C. Non-viewable heat sink.
- D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.
- E. Dimmer to match device color.
- F. SW-D-LED; LED Electronic Driver Dimmer:
  1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60629 Annex E.
  2. Manufacturers:
    - a. Compatible with provided LED driver.

- G. SW-D-LVE; Low Voltage Electronic Ballast Dimmer:
1. 120-volt, linear slider operator with positive off. 450 watt capacity.
  2. Manufacturers:
    - a. Lutron NELV-450
    - b. Lightolier MP625QE
- H. SW-D-LVM; Low Voltage Magnetic Ballast Dimmer:
1. 120-volt, linear slider operator with positive off. Subscript denotes wattage, 6=450W, 10=800W, 15=1200W.
  2. Manufacturers:
    - a. Lutron NLV-600NLV-1000NLV-1500
    - b. Lightolier
- I. SW-D3-LED; LED Electronic Driver Three-Way Dimmer:
1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60929 Annex E.
  2. Manufacturers:
    - a. Compatible with provided LED driver.
- J. SW-OD; Wall 0-10V Dimmer / Occupancy sensor:
1. Wall switch with manual on/auto off. 120VAC load rating of 0-800 W for electronic ballast, LED. 277VAC load rating of 0-1,800 W for electronic ballast, LED. adjustable OFF delay. 0-10V dimming with up to 30ma sink. Automatic ON/OFF, manual ON/automatic OFF, or occupancy on to predetermined dimming level go to last dimming setting upon occupancy.
  2. Manufacturers:
    - a. Sensor Switch WSX D Series

## 2.7 LOCAL DAYLIGHTING CONTROLS

- A. Standalone Interior Photo Sensors:
1. SW-LS; Daylight Level Sensor - On/Off Control - One Zone:
    - a. On/Off control. Range of 10-200 FC. Adjustable deadband prevents cycling. Adjustable time delay. 120/277 volt.
    - b. Manufacturers:
      - 1) Watt Stopper LS-102
      - 2) Sensor Switch CM-PC
      - 3) Hubbell Automation DLCPC Series
      - 4) Greengate PPS-4



2. SW-LS-3Z; Daylight Level Sensor and Controller - On/Off Control - Three Zones:
  - a. On/off control of up to three 10-amp zones. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. 120/277 volt.
  - b. Manufacturers:
    - 1) Watt Stopper LCO-203/LS-290C
    - 2) Hubbell Automation LUXSTATOCM/LUXSTATLS
    - 3) LC&D Micro GR/2404 iDH/Pcell
    - 4) Sensor Switch N-CMPC
  
3. SW-LS-D: Daylight Level Sensor and Controller - 0-10V Dimming - One Zone:
  - a. Dimming control of one 0-10V zone. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. Coordinated with dimming ballast prior to submittal.
  - b. Manufacturers:
    - 1) Watt Stopper LS-301
    - 2) Hubble Automation DLC7
    - 3) Sensor Switch N-CMADC
  
4. SW-LS-D-3Z; Daylight Level Sensor and Controller - Dimming - Three Zones:
  - a. Dimming control of up to three zones of 0-10V. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. Coordinate with dimming ballasts prior to submittal.
  - b. Manufacturers:
    - 1) Watt Stopper LCD-203/LS-290C
    - 2) Hubbell Automation LUXSTATDCM/LUXSTATLS
    - 3) LC&D Micro GR/2404 IDIM/Pcell
    - 4) Sensor Switch N-CMADC.
  
5. SW-LS-M; Daylight Level Sensor and Controller - Multilevel/Bi-level On/Off Control - Dual Zones:
  - a. Multilevel/bi-level on/off control of up to two 10-amp zones. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. 120/277 volt.
  - b. Manufacturers:
    - 1) Watt Stopper LCO-203/LS-290C
    - 2) Hubbell Automation DLCPCC/DLCPCI
    - 3) Sensor Switch CM-PC-DZ
  
6. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.
7. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:
  - a. Ambient sensitivity range between 1 and 1,000 foot-candles.
  - b. Time delay of 5 to 300 seconds.
  - c. Trigger setpoints with deadband adjustment.

8. Sensor shall provide on/off setpoints in quantity as specified on drawings and as shown in the sequence of operation.
9. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.
10. Output signal from sensor shall be linear with light level.

B. SW-LS-PC; Standalone Exterior Photo Sensors:

1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.
3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.
4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
  - a. Ambient sensitivity range of 5 to 1,500 foot-candles.
  - b. Adjustable setpoint.
  - c. Deadband adjustment by percentage of setpoint.
  - d. Time delay of up to five minutes.
5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
6. Manufacturers:
  - a. Paragon
  - b. Tork
  - c. Intermatic

## 2.8 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
4. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
  - c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.
  7. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
  8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
  9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
  10. Warranty: Five (5) year warranty.
- B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. SW-VS-D or SW-OC-D; 360 Degree Coverage Pattern:
    - a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.
    - b. Manufacturers:
      - 1) Watt Stopper DT 300 Series
      - 2) Hubbell OMNI-DT2000 or ATD2000C
      - 3) Greengate OAC-DT
      - 4) Leviton OSC##-MOW
      - 5) Sensor Switch CM PDT 10
  2. SW-VS-D-W or SW-OC-D-W; Wall Mounted on Adjustable Swivel Mount:
    - a. Wall or ceiling sensor with adjustable settings to allow manual on/auto off or auto on/auto off. Integrated ambient light level sensor (2 to 100 FC range).
    - b. Manufacturers:
      - 1) Watt Stopper DT-200 Series
      - 2) Hubbell LODTRP
      - 3) Leviton OSM12--M series
      - 4) Sensor Switch WvPDT 16 Series
  3. SW-O; Wall Switch:
    - a. Wall switch with manual on/auto off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
    - b. Manufacturers:
      - 1) Watt Stopper DW-100 Series
      - 2) Hubbell LHMTS, Leviton OSSMT series
      - 3) Sensor Switch WSX-PDT SA Series
  4. Sensitivity Adjustment: Separate for each sensing technology.

5. Detection Coverage:
  - a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
  - b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.
  
- C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
  
- D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
  1. SW-O; Wall Switch Occupancy Sensor:
    - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC. Manual ON for vacancy sensing.
    - b. Manufacturers:
      - 1) Watt Stopper PW-100 Series
      - 2) Sensor Switch WSX
      - 3) Hubbell LHIRS1 or AP1277
      - 4) Leviton ODS15
      - 5) Greengate OSW-P-0451
  
  2. SW-OC-P-P; Ceiling Mounted - 360 Degree Coverage Pattern:
    - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
    - b. Manufacturers:
      - 1) Watt Stopper CI Series
      - 2) Sensor Switch CM-9
      - 3) Hubbell Automation Omni-IR
      - 4) Leviton OSC Series
      - 5) Greengate OMR-P Series
  
  3. SW-OC-P-P2; Ceiling Mounted - 100 Degree Coverage Pattern:
    - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
    - b. Manufacturers:
      - 1) Watt Stopper WPIR Series
      - 2) Sensor Switch CM-9
      - 3) Hubbell LOIRWV or ATD1600W

4. SW-OC-P-W; Wall Mounted - 100 Degree Coverage Pattern:
  - a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: Ambient sensor 40 FC.
  - b. Manufacturers:
    - 1) Watt Stopper WPIR Series
    - 2) Sensor Switch CM-9
    - 3) Hubbell LOIRWV or ATD1600W
5. With daylight filter and lens to afford coverage applicable to space to be controlled.

## 2.9 AUTOMATIC LOAD CONTROL RELAY (ALCR) (INDIVIDUAL LUMINAIRE - INTEGRAL)

- A. This section includes information related to factory and field installed ALCR devices intended for individual luminaires.
- B. ALCR3; Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32°F to 113°F (0°C to 45°C) operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, listed for factory or field installation within luminaire, UL924 listed latest edition, Electrical Code Article 700 compliant.
  1. Rating: 3 Amp LED driver, ballast, or incandescent.
  2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: Switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
  3. Operation:
    - a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
    - b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
    - c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
    - d. Performance Equivalent by Other Components: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system.
      - 1) Remote test switch / fire alarm override interface.
      - 2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.
    - e. Accessory - Remote Test Switch: Provide a remote button test switch for all ALCR3 devices associated with the same lighting control zone. The test switch shall be a single gang type switch compatible with the ALCR device and allow the remote fire alarm override to function.

- 1) Test Switch Mounting:
  - a) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
  - b) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
  - c) Unfinished Spaces: Adjacent and aligned with local wall-mounted lighting controls.

4. Manufacturers:

- a. LVS Controls EPC-2-FM (switched)
- b. EPC-2-D-FM Series (0-10V dimming)
- c. EPC Series (alternative lighting control)
- d. Iota ETS-step (switched)
- e. ETC-DR (0-10V dimming)
- f. ETC Series (alternative lighting control)
- g. Lighting control manufacturer

## 2.10 AUTOMATIC LOAD CONTROL RELAY (ALCR)

- A. ALCR20; Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32°F to 113°F (0°C to 45°C) operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating:

- a. 20 amp (16 A permitted) LED driver and ballast.
- b. 10 A (1,200 watt) incandescent.

2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.

3. Operation:

- a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
- b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
- c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
- d. Equivalent Facilitation and Performance: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system:

- 1) Remote test switch / fire alarm override interface.

- 2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.
- e. Accessory - Remote Test Switch: Provide a remote button test switch. The test switch shall be a single gang type switch compatible with the ALCR device and allow the remote fire alarm override to function.
  - 1) Test Switch Mounting:
    - a) Finished Spaces (ceiling height 10 feet or less): Flush mount device in finished ceiling adjacent to one of the emergency lights.
    - b) Finished Spaces (ceiling height greater than 10 feet): Flush mounted in wall. Refer to Architect/Engineer for location.
    - c) Unfinished Spaces: Adjacent and aligned with local wall-mounted lighting controls.
    - d) Option: ALCR device(s) with a test button, visual indicator, and flush mounting plate may be installed in the location of the remote test switch in lieu of providing a separate remote test switch.
- 4. Manufacturers:
  - a. LVS Controls EPC-2 (switched)
  - b. EPC-2-D Series (0-10V dimming)
  - c. EPC-DMX (DMX) EPC Series (alternative lighting control)
  - d. Iota ETS-20 (switched)
  - e. ETC-20-DR (0-10V dimming)
  - f. ETC Series (alternative lighting control)
  - g. Myers Emergency Power Systems RLY-SW-2 (switched)
  - h. RLY-DIM-2D (0-10V dimming)
  - i. RLY Series (alternative lighting control)
  - j. Nine24 Inc ELCR-R (switched)
  - k. ELCR-Z10 (0-10V dimming)
  - l. ELCR Series (alternative lighting control)
  - m. Lighting control manufacturer

## 2.11 DISTRIBUTED LIGHTING CONTROL

- A. Manufacturers: as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.
  - 1. Acuity Controls nLight Series
  - 2. Legrand Watt Stopper DLM Series
  - 3. Hubbell Automation NX Series
  - 4. Eaton Greengate RC3 Series (room-based system)
  - 5. Osram Encelium Series
  - 6. Lutron
- B. System Description: The lighting control system shall be a network of remote modules. System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

- C. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.
- D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.
- E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.
- F. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system.
- G. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation, and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- H. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs, and control system server/ central station such that system performs as described. Server shall be provided with monitor, keyboard, and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.
- I. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network hub shall be fed from an equipment emergency circuit at a minimum.

## 2.12 CENTRAL LIGHTING CONTROL INTERFACES

- A. SW-LV; Manual Switches, Stations and Plates:
  1. Switches: Modular, momentary pushbutton, with addressable capabilities to control the luminaires assigned to that switch. The switch shall be able to actuate the functions based on the described sequence of operation and intended functions.
  2. Preset/fader stations shall operate using programmable buttons and/or faders as indicated on drawings.
  3. Integral Pilot Light or LED: Indicate that controls are active or powered by being on continuously when powered or when pushbuttons are actuated.
  4. Labeling of buttons and faders shall be engraved/screened by manufacturer, using approved text returned with shop drawing submittals.
  5. Station control components shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via direct or network connection. Function options include: preset selection, manual mode, record mode, station lockout, raise/lower, macro, cue, and room join/separate.



B. LCD-SW; LCD Station:

1. Backlit liquid crystal display (LCD) shall operate using buttons, faders, and other images on separate programmable control pages via touchscreen interface.
2. LCD station contrast and brightness shall be adjustable. It shall be possible to program the station to dim during periods of inactivity.
3. LCD stations shall support import of bitmap image files to customizable pages.
4. Permanently installed stations shall be either fully or semi-recessed in manufacturer-furnished backbox and trim assembly, with no visible fasteners or hardware.
5. Portable stations shall nest into permanent wall docking station furnished by manufacturer, and shall not require user to connect any umbilicals or plugs when inserting or removing the portable device. Docking station shall provide charging and communication with portable device when docked.

C. Wireless Controls (Infrared):

1. Portable wireless IR transmitter for remote control of lighting control panel. Transmitter shall have at least four (4) scene control with engraved names below each button.
2. Infrared receiver shall be recess mounted with an integral LED to indicate when signal has been received. Receiver shall operate reliably within a 40-foot distance.

D. Portable Control Console and Connector Station:

1. Portable control console with minimum 10-foot cable and interface plug.
2. Connector station receptacle, flush mounted, to allow portable console to communicate with lighting control system. Mounts in industry standard backbox.

E. LS-N; Network Daylight Level Sensor:

1. Networked sensors shall serve as a measurement device that provides ongoing read-back of sensor settings to lighting control network or daylight controller. Refer to the sequence of operation for actions to be triggered at various read-back values.
2. Sensor shall be ceiling- or wall-mounted for range and viewing angle, meeting application requirements as outlined in the sequence of operation. Outdoor sensors shall be wet location listed and designed specifically for outdoor use.
3. Output signal from sensor shall be linear with light level. Network connection permits remote query of sensor status and value via control software. All adjustments, with the exception of sensor range, shall be made via network connection.
4. Sensor shall have adjustable sensitivity range to permit use as scheduled.

## 2.13 LIGHTING CONTROL SYSTEM - DIGITAL ADDRESSABLE LIGHTING INTERFACE (DALI)

A. Manufacturers: listed below meet the qualifications as outlined within this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Starfield Controls, Inc.
2. Tridonic Inc.

- B. System Description: The lighting control system shall consist of digital lighting control network connecting DALI-compliant digital addressable ballasts, control modules, and lighting control devices directly with a system server / central control station. Individually addressable electronic ballasts, control modules, and control devices are operated from signals received through DALI-compliant bus from a variety of DALI-compliant digital controllers and interfaces and programmed through the system server / central control station. System includes all associated network bus and wiring, DALI controllers and interfaces, panels, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize DALI-compliant ballast and dimming modules provided with light fixtures.
- C. Control Devices: All occupancy sensors (ultrasonic, IR, and dual technology type), photocells, switches, and timers shall be provided with system and be DALI compliant. Devices shall be designed to operate on system network. Supplemental DALI-compliant signal repeaters and controllers shall be provided as required. This equipment shall be identified in shop drawing submission.
- D. System shall include server / central station with DALI operating software, data network, and BACnet IP communication with other systems as described.
- E. System server / central station shall provide programmable operation of lights connected via system bus and controlled with system devices. System software shall provide control of DALI ballast, control modules and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

#### **2.14 ARCHITECTURAL DIMMER RACK AND ACCESSORIES**

- A. SW-DCS; Dimmer Control Station
  - 1. 5 buttons, presets, and on/off control.
- B. SW-LCS; Dimmer Control Station with Faders
  - 1. 4 buttons, 2 faders.
- C. Dimming / Relay Performance Requirements:
  - 1. The component's maximum current rating shall be at least two times the dimmer's/relay's rated operating current.
  - 2. Capable of withstanding repetitive in-rush current of 50 times operating current without impacting lifetime of dimmer/relay. Design and test dimmers/relays to withstand line-side surges without impairment to performance.
  - 3. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.
- D. Dimmers:
  - 1. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
  - 2. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
  - 3. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.
  - 4. Possess ability to have load types assigned per circuit, configured in field.
  - 5. Minimum and maximum light levels user adjustable on output-by-output basis.

6. Line Voltage Dimmers: Meet following load-specific requirements:
  - a. Magnetic Low Voltage (MLV) Transformer:
    - 1) Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
    - 2) Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
  - b. Electronic Low Voltage (ELV) Transformer:
    - 1) Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
  - c. Neon and Cold Cathode Transformers:
    - 1) Magnetic Transformers: UL listed for use with normal (low) power factor magnetic transformers.
    - 2) Electronic Transformers:
    - 3) Must be supported by the ballast equipment manufacturer for control of specific ballasts being provided.
  - d. Fluorescent Electronic Dimming Ballast:
  - e. Refer to Section 265100 for dimming ballast specifications and performance.
7. Low Voltage Dimming Modules: Meet the following requirements:
  - a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
  - b. Single low voltage dimming module; capable of controlling following light sources:
    - 1) 0-10V analog voltage signal
    - 2) DSI digital communication
    - 3) DALI broadcast communication IEC 60929
    - 4) PWM IEC 60929

E. Non-dim circuits to meet the following requirements:

1. Rated life of relay at full load: Minimum 1,000,000 cycles.
2. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
3. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

## 2.15 TIME SWITCH

- A. TC-7; Time switch, 7-day, 2 channel, electronic, two SPDT 15-amp contacts, two separate programs with 16 setpoints available, LCD display, 12 or 24-hour format, minimum 100 hours carry-over, UL listed.
  1. Manufacturers:
    - a. Paragon EC72

- b. Tork DTS 200A
  - c. Intermatic ET70215C
- B. TC-S; Timer, 24-hour, 20-amp continuous contacts, 1 N.O. and 1 N.C. contacts, spring wound backup, 120 volt, override switch, UL listed.
  - 1. Manufacturers:
    - a. Paragon 4213-OS
    - b. Tork 7200L
    - c. Intermatic T173CR

## **2.16 CONDUCTORS AND CABLES**

- A. Control Wiring:
  - 1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 260513 "Wire and Cable."
  - 2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.
  - 3. Tap conductors to dimming ballasts: Solid copper conductors of 18 AWG with insulation voltage rating equal to that of the line-voltage wiring and insulation temperature rating not less than 90°C.
  - 4. Network cabling as required by manufacturer.
- B. Splices and Taps:
  - 1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

## **PART 3 - EXECUTION**

### **3.1 PRE-CONSTRUCTION MEETING**

- A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control centralized, wireless, and distributed systems.

### **3.2 EXAMINATION**

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts existing conditions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. All wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballast and other RFI/EMI sources.
- C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

### 3.4 AUTOMATIC LOAD CONTROL RELAYS (ALCR20) AND BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTS)

- A. Field install per manufacturer requirements.
- B. Remote Test Switch: Provide connection to remote test switch.
- C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

### 3.5 SUPPORT SERVICES

- A. System Startup:
  1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.
- B. Testing:
  1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
  2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:
    - a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
    - b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
    - c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
  3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
  4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
    - a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
    - b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

- C. Training:
  - 1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
  - 2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.
  
- D. Documentation:
  - 1. Manufacturer shall provide system documentation including:
    - a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
    - b. Drawings for each panel showing hardware configuration and numbering.
    - c. Panel wiring schedules.
    - d. Typical diagrams for each component.

### **3.6 SYSTEM COMMISSIONING**

- A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements.
- B. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent.
- C. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans.

END OF SECTION 260933

**SECTION 262200 - DRY TYPE TRANSFORMERS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Dry type two winding transformers
- B. Dry type buck and boost transformers

**1.2 REFERENCES**

- A. NEMA - ST 1 - Specialty Transformers
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
- D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
- E. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

**1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect products under provisions of Section 260500.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

**PART 2 - PRODUCTS**

**2.1 DRY TYPE TWO WINDING TRANSFORMERS**

- A. Acceptable Manufacturers:
  1. Square D 7400 EX##T / SK300##KB Series
  2. Eaton V48M / H48M / B48M Series
  3. ABB 9T Series
  4. Hammond SG / SMK Series
  5. Siemens 3F3 Series
  
- B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

Ratings	Class	Rise (degree C)
Less than 15 or higher	185 220	As shown on the drawings As shown on the drawings

- D. Case temperature shall not exceed 40°C rise above ambient at its warmest point.
- E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
- F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.
- G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

- H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.



- I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.
- J. Coil Conductors: Continuous windings with terminations brazed or welded.
- K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.
- L. Isolate core and coil from enclosure using vibration-absorbing mounts.
- M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

**2.2 DRY TYPE BUCK AND BOOST TRANSFORMERS**

A. Acceptable Manufacturers:

- 1. Square D
- 2. Eaton
- 3. ABB
- 4. Hammond
- 5. Siemens
- 6. ACME

B. Dry Type Buck and Boost Transformers: ANSI/NEMA ST 1; factory-assembled, dry type two winding buck and boost transformers; ratings as shown on the drawings.

KVA Rating	Insulation Class	Temperature Rise (degree C)
0.25-2	185	80
3-7.5	220	115

C. Insulation system and average winding temperature rise for rated KVA as follows:

KVA Rating	Insulation Class	Temperature Rise (degree C)
0.25-2	185	80
3-7.5	220	115

- D. Mounting: Wall or as shown on drawings.
- E. Coil Conductors: Continuous windings.
- F. Enclosure: ANSI/NEMA ST 1; Type 1.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data.

**2.3 ACCESSORIES**

A. Provide REQUIRED accessories as described below. Provide SCHEDULED accessories when listed with plan schedules. Refer to plan schedules for additional requirements.

- B. Electronic Isolation Shield:
  - 1. Provide electrostatic winding shield with separate insulated grounding connection as shown on the drawings. REQUIRED

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on four 3"x3"x1/2" thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.
- E. Install primary, secondary, and grounding electrode conductors using factory or field fabricated enclosure entries. Conductors shall not be routed through ventilated openings.

#### **3.2 FIELD QUALITY CONTROL**

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION 262200

**SECTION 262413 - SWITCHBOARDS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Main and distribution switchboards: MSB

**1.2 RELATED SECTIONS AND WORK**

- A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

**1.3 REFERENCES**

- A. ANSI C12 - Code for Electricity Metering
- B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments
- C. ANSI C57.13 - Requirements for Instrument Transformers
- D. NEMA AB 1 - Molded Case Circuit Breakers
- E. NEMA KS 1 - Enclosed Switches
- F. NEMA PB 2 - Dead Front Distribution Switchboards
- G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or less

**1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.
- D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.
- E. Submit manufacturer's instructions under provisions of Section 260500.

**1.5 SPARE PARTS**

- A. Keys: Furnish four each to the Owner.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to the site under provisions of Section 260500.
- B. Deliver in 48-inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 260500.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

**1.7 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data under provisions of Section 260500.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. Approved Manufacturers:
  - 1. Square D Class 2700 QED-2, I-Line, Powerstyle
  - 2. ABB Spectra / Evolution
  - 3. Siemens
  - 4. Eaton

**2.2 RATINGS**

- A. Definitions:
  - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. Refer to Section 260553 for additional requirements.
  - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The switchboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

**2.3 SWITCHBOARD CONSTRUCTION AND RATINGS**

- A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.

- B. Switchboard electrical ratings and configurations as shown on the drawings.
- C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.
- D. Main Section Devices: Individually mounted and compartmented.
- E. Distribution Section Devices: Individually mounted.
- F. Auxiliary Section Devices: Individually mounted and compartmented.
- G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.
- H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.
- I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.
- J. The bus shall extend the full height of the distribution sections to provide space for future breakers.
- K. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.
- L. Provide metering transformer compartment for Utility Company's use. Compartment size, bus spacing and drilling, door, and locking and sealing requirements shall be in accordance to Section 262000 and Utility Company specifications.
- M. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear. Provide removable panel access or hinged door with flush lock and all keyed alike. Door hardware shall provide swing clear operation (180-degree swing).
- N. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.
- O. Maximum Dimensions: 72 inches L x 24 inches W x 96 inches H.
- P. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- Q. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.
- R. Pull Section: Same construction as switchboard, size as shown on the drawings. Depth and height to match switchboard. Arrange as shown on the drawings.
- S. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.
- T. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

## 2.4 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION

- A. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.
- B. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 2,500 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with restricted access and a sealable clear cover. Provide Ground fault sensing shall be breaker integral with circuit breaker. Provide breaker interrupting ratings as indicated on the plans.
- C. Solid-State Insulated Case Circuit Breakers: (All breakers identified on plans as solid state with frame sizes above 2,500 ampere.) Provide insulated case switch with two-step stored energy closing. Provide manual charging handle, and electric charging motor where indicated as electrically operated. Provide with rating plug as required on drawings and electronic circuits for true rms current sensing, timing, and tripping for fully adjustable time current characteristics including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip settings shall be field programmable with restricted access and a sealable clear cover. Ground fault sensing shall be summation type integral to breaker. Provide stationary mounting. Provide breaker interrupted ratings as indicated on the plans.
- D. Arc Energy Reduction with Selective Coordination:
  - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
  - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch at the entrance to the electrical room.
  - 3. The following selective coordination and arc energy reduction system options are acceptable:
    - a. Zone-selective interlocking with permanent arc energy reduction
    - b. Differential relaying with permanent arc energy reduction
    - c. Listed energy-reducing active arch flash mitigating system

## 2.5 INSTRUMENTS AND SENSORS

- A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- B. Potential Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Ground Fault Sensor: Zero sequence type.

- D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- E. Double-ended Equipment Ground Fault Protection: Provide a modified differential ground fault protection scheme.
- F. Electronic Power Monitor: Refer to Section 260913.
- G. DPM; Digital AC Power Monitor: Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.
- H. ITDM; Impulse-Totalizing Demand Meter: ANSI C12.1; suitable for use with switchboard watt-hour meter, including two circuit totalizing relays; cyclometer; four dial totalizing kilowatt-hour register; positive chart drive mechanism; capillary pen holding minimum one-month ink supply; and roll chart with minimum 31-day capacity. Indicate and record 15-minute integrated demand of totalized system.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- C. Install fuses in each switch.

#### **3.2 FIELD QUALITY CONTROL**

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.
- D. Physically test key interlock systems to ensure proper function.

#### **3.3 ADJUSTING AND CLEANING**

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

- C. Provide time/current trip curves for all adjustable protection devices that require setting. Also provide curves and equipment information for associated new and existing fixed devices that require coordination with new protection devices. Submit time/current curves in hard copy or electronic format.
- D. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.
- E. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer's directions. Provide testing documentation with Operating & Maintenance Manual submittals.

END OF SECTION 262413



**SECTION 262416 - PANELBOARDS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Service and distribution panelboards: DP-#, DP-#
- B. Lighting and appliance branch circuit panelboards: Panel '###'
- C. Load centers: Panel '###'

**1.2 RELATED SECTIONS AND WORK**

- A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

**1.3 REFERENCES**

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA FU 1 - Low voltage cartridge fuses
- C. NEMA KS 1 - Enclosed Switches
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
- G. UL 248 - Low-Voltage Fuses
- H. UL 67 - Panelboards

**1.4 SUBMITTALS**

- A. Submit shop drawings for equipment and component devices under provisions of Section 260500.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.
- D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.
- E. Refurbished branch panel enclosure documentation for new branch panelboards installed in existing enclosures.

- F. Submit manufacturer's instructions under provisions of Section 260500.

## 1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish 10% or a minimum of three (3) spare fuses of each type and rating installed to the Owner.
- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

## PART 2 - PRODUCTS

### 2.1 RATINGS

- A. Definitions:
  1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 260553 for additional requirements.
  2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

### 2.2 MAIN AND DISTRIBUTION PANELBOARDS

- A. General
  1. Manufacturers:
    - a. Square D QMB, I-Line
    - b. ABB ReliaGear Entelleon
    - c. Siemens F2, P4
    - d. Eaton PRL4, PRL5
- B. Panelboards: NEMA PB 1; type as shown on the drawings.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

- G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.
- H. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- I. Fuse Clips (Switches 600 Amperes and Smaller): Provide with Class 'R' rejection clips. Fuse Clips (601 Amperes and Larger): Designed to accommodate Class 'L' fuses.
- J. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- K. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.
- L. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- M. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 1,200 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with restricted access and a sealable clear cover.
- N. Arc Energy Reduction:
  - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
  - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch at the entrance to the electrical room.
- O. Suitable for use as service entrance equipment. Provide line side (service style) barriers.
- P. Maximum Dimensions: 36 inches L x 16 inches W x 96 inches H.

### 2.3 BRANCH CIRCUIT PANELBOARDS

- A. General
  - 1. Manufacturers:
    - a. Square D NQ, NF
    - b. ABB A Series
    - c. Siemens P1
    - d. Eaton PRL1, PRL2
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copperbus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.
- K. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- L. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

## **2.4 COLUMN WIDTH PANELBOARDS**

- A. General
  - 1. Manufacturers:
    - a. Square D NQ, NF
    - b. ABB A Series
    - c. Siemens P1
    - d. Eaton PRL1-LX, PRL2-LX
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

## 2.5 LOAD CENTERS

- A. General
  - 1. Manufacturers:
    - a. Square D
    - b. ABB
    - c. Siemens
    - d. Eaton
- B. Load Centers: Circuit breaker load center.
- C. Enclosure: General-Purpose.
- D. Provide lock on door. Finish in manufacturer's standard gray enamel.
- E. Provide load centers with bus ratings as shown on the drawings.
- F. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical.
- G. Molded Case Circuit Breakers: Provide plug-on circuit breakers with integral thermal and instantaneous magnetic trip in each pole, with common trip handle for all poles. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings.
- H. Do not use tandem circuit breakers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.

- D. Provide custom typed circuit directory for each branch circuit panelboard. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.
- E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

### **3.2 REFURBISHED ENCLOSURES - NEW PANELBOARDS**

- A. Existing panelboard enclosures may be reused to house new panelboards pending documented verification of the following provided with the applicable new equipment submittals.
  - 1. New branch panelboard is listed for the existing enclosure or application.
  - 2. Existing enclosure and new equipment is field evaluated by the manufacturer or nationally recognized testing laboratory for the available fault current, condition, and application.
  - 3. Authority Having Jurisdiction AHJ approval.

### **3.3 FIELD QUALITY CONTROL**

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION 262416

**SECTION 262726 - WIRING DEVICES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Device plates and box covers
- B. Modular connectors
- C. Receptacles (REC-#)
- D. Countertop and furniture receptacle assemblies (REC-#)
- E. Pin and sleeve devices (REC-Z#)
- F. Floor boxes and floor box with service fitting (FB-#)
- G. Poke-through fittings (PT-#)
- H. Pendant cord/connector devices
- I. Cord and plug sets
- J. Cord reel (CR-#)

**1.2 QUALITY ASSURANCE**

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with the Electrical Code.

**1.3 REFERENCES**

- A. DSCC W-C-896F - General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 - General Color Requirements for Wiring Devices
- D. NEMA WD 6 - Wiring Devices - Dimensional Requirements
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL 498 - Standard for Attachment Plugs and Receptacles
- G. UL 943 - Standard for Ground Fault Circuit Interrupters

**1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.
- C. Provide a non-returnable sample of each countertop and furniture-mounted receptacle assembly as part of the submittal process.

**1.5 COORDINATION**

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.
- B. Cord and Plug Sets: Match equipment requirements.
- C. Coordinate installation of receptacle assemblies in countertops and furniture with the Contractor providing the countertop or furniture. Contractor shall coordinate penetrations and conduit routing in countertops and furniture with drawings and other obstacles below the installation surface.

**PART 2 - PRODUCTS****2.1 DEVICE COLOR**

- A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

**2.2 COVERPLATES**

- A. All switches, receptacles, and outlets shall be complete with the following:
  - 1. Unbreakable thermoplastic/thermoset plastic and match device color coverplates in finished spaces where walls are finished.
  - 2. Decorator Grade - Public: Decorator thermoset plastic and match device color thermoplastic and match device color #302 stainless steel wallplates in public finished spaces where walls are finished.
    - a. Manufacturer:
      - 1) Leviton Decora
      - 2) Hubbell Decorator
      - 3) Cooper Decorator
      - 4) or approved equal
  - 3. Decorator Grade - Screwless: Decorator snap-on nylon or polycarbonate wallplates with sub-base in public finished spaces; match device color.
    - a. Manufacturer:
      - 1) Leviton 803##
      - 2) Hubbell RCW
      - 3) Cooper PJS



- 4) Pass & Seymour SWP
- 5) or approved equal

- 4. #302 stainless steel coverplates in unfinished spaces for flush boxes.
- 5. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.

- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 260553.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

### 2.3 MODULAR CONNECTORS

- A. Devices listed below are traditional wired devices. Contractor option to provide equivalent modular connector-type devices (Hubbell Snap Connect, Pass & Seymour Plug Tail, Leviton Lev-Lock, Copper ArrowLink) where applicable.
- B. Wiring devices with modular wiring type quick connectors shall comply with the following in addition to the above:
  - 1. Wired with #12 THHN Cu, stranded or solid, 3 or 4 wire as required for device, minimum 6" lead length.
  - 2. Connector contacts shall be crimped or welded.

### 2.4 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. Devices that are shaded on the drawings shall be red.
- C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.
- D. REC-DUP: NEMA 5-20R Duplex Receptacle:
  - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
    - a. Manufacturers:
      - 1) Hubbell 5352A
      - 2) Leviton, 5362-S
      - 3) Pass & Seymour 5362
      - 4) Cooper 5352
  - 2. Decorator Grade: Provide decorative style duplex receptacles in public spaces where walls are finished.
    - a. Manufacturers:
      - 1) Hubbell DR20
      - 2) Leviton 16362

- 3) Pass & Seymour 26342
    - 4) Cooper 6352
  - 3. Spec Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap.
    - a. Manufacturers:
      - 1) Hubbell 5352
      - 2) Leviton 5362-S
      - 3) Pass & Seymour 5362
      - 4) Cooper 5362
  - 4. Heavy Duty: 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.
    - a. Manufacturers:
      - 1) Hubbell 5362
      - 2) Leviton 5362
      - 3) Pass & Seymour 5362A
      - 4) Cooper AH5362
- E. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:
  - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, listed.
    - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    - b. Manufacturers:
      - 1) Hubbell GF20L
      - 2) Leviton GFNT2
      - 3) Pass & Seymour 2097
      - 4) Cooper SGF20
- F. REC-DUP-GFI-R: Remote Ground Fault Device:
  - 1. Ground fault device for remote downstream receptacles. 125-volt, 20 amp. Test and reset buttons in impact resistance thermoplastic face, listed.
    - a. Manufacturers:
      - 1) Hubbell GFBF20
      - 2) Leviton 6895
      - 3) Pass & Seymour 2085
      - 4) Cooper VGFD20
- G. REC-DUP-WP: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
  - 1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.

2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

a. Manufacturers:

- 1) Hubbell:
  - a) GFTWRST20 with aluminum housing WP826
- 2) Leviton GFWT2 with aluminum housing M5979
- 3) Pass & Seymour 2097TRWR with aluminum housing WIUCAST1
- 4) Cooper WRSGF20 with aluminum housing WIUMV-1

H. REC-DUP-O: NEMA 5-20R 2121 Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and brass back strap. Both halves of duplex controlled by remote relay. Controlled receptacle shall have permanent NEMA approved and Electrical Code compliant marking on face of device.

a. Manufacturers:

- 1) Hubbell BR20C2
- 2) Leviton 5362-2P
- 3) Pass & Seymour 5362CD\*
- 4) Eaton 5362CD

I. REC-DUP-XP: NEMA 5-20R Explosion Proof Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1 rated. Spring-loaded cover with gasket. Mount in cast box with threaded openings.

a. Manufacturers:

- 1) Appleton EFSC175
- 2) Crouse-Hinds ENRC21201
- 3) Killark UGR5-20231

J. REC-DUP-IL: NEMA 5-20R Illuminated Face Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type hospital grade with impact resistant thermoplastic face and one-piece nickel-plated brass back strap with integral ground contacts.
2. Device shall be red.
3. Devices shall have an illuminated face or indicator light to indicate that there is power to the device.

a. Manufacturers:

- 1) Hubbell HBL8300ILR
- 2) Leviton 8300-HLR
- 3) Pass & Seymour 8300IL
- 4) Eaton AH8300LT

- K. REC-ISO: NEMA 5-20R Isolated Ground Duplex Receptacle:
1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with orange impact resistant thermoplastic face. Orange Stainless coverplate with 'Isolated Ground' stenciled in black.
    - a. Manufacturers:
      - 1) Hubbell IG20
      - 2) Leviton 5362-IG
      - 3) Pass & Seymour IG5362
      - 4) Cooper IG5362
- L. REC-ISO-SUR: NEMA 5-20R Isolated Ground and Surge Suppression Duplex Receptacle:
1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with orange impact resistance thermoplastic face, light, and alarm. Orange Stainless coverplate with 'Isolated Ground' stenciled in black.
    - a. Manufacturers:
      - 1) Hubbell IG5362OSA
      - 2) Leviton 5380-IG
      - 3) Pass & Seymour IG5362-OSP
      - 4) Cooper IG5362RNS
- M. REC-ISO-SUR-QUAD: NEMA 5-20R Double Duplex Isolated Ground and Surge Suppression Receptacle:
1. Consists of two duplex isolated ground and surge suppression receptacles, double gang box, plaster ring and faceplate.
    - a. Manufacturers:
      - 1) Refer to Isolated Ground and Surge Suppression Receptacle above.
- N. REC-USB: NEMA 5-20R Receptacle with USB Charger:
1. Standard Grade Type A USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Type A USB charging rated at 5VDC 3.0A minimum. Mounted in double gang backbox.
    - a. Manufacturers:
      - 1) Hubbell USB20X2
      - 2) Pass & Seymour TR5362USB
      - 3) Cooper TR7766
  2. Standard Grade Type C USB: 125-volt, 20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face.
    - a. Two Type C USB charging rated at 5VDC 5.0A. Mounted in double gang backbox.
    - b. Manufacturers:
      - 1) Hubbell USB USB20C5

- O. REC-AFGF: NEMA 5-20R Duplex Receptacle with Arc Fault Circuit Interrupter, Ground Fault Circuit Interrupter, and Tamper Resistant:
1. 125-volt, 20 amp, 3-wire grounding type specification grade, arc fault circuit interrupter, ground fault circuit interrupter, tamper resistant receptacle with test and reset buttons in impact resistant thermoplastic face, listed.
    - a. Device shall perform self-test of GFCI circuitry in accordance with UL-943.
    - b. Manufacturers:
      - 1) Hubbell AFGF
      - 2) Leviton AGTR2
      - 3) Pass & Seymour AFGF202
      - 4) Cooper TRAFGF20A
- P. REC-ARC: NEMA 5-20R Receptacle with Arc Fault Circuit Interrupter:
1. 125-volt, 20 amp, 3-wire grounding type specification grade, arc fault circuit interrupter receptacle and tamper resistant with test and reset buttons in impact resistant thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell AFR20
      - 2) Leviton AFTR2
      - 3) Pass & Seymour AF202
      - 4) Cooper TRAFCI20
- Q. REC-SIM-520R: NEMA 5-20R Simplex Receptacle:
1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell HBL5361
      - 2) Leviton 5361
      - 3) Pass & Seymour 5361
      - 4) Cooper 5361
- R. REC-SIM-530R: NEMA 5-30R Simplex Receptacle:
1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.
    - a. Manufacturers:
      - 1) Hubbell HBL9308
      - 2) Leviton 5371
      - 3) Pass & Seymour 3802
      - 4) Cooper 5716N
- S. REC-SIM-550R: NEMA 5-50R Simplex Receptacle:
1. 125-volt, 50 amp, 3-wire grounding type, phenolic face.

- a. Manufacturers:
    - 1) Hubbell HBL9360
    - 2) Cooper 1253
- T. REC-SIM-620R: NEMA 6-20R Simplex Receptacle:
- 1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell HBL5461
      - 2) Leviton 5461
      - 3) Pass & Seymour 5871
      - 4) Cooper 5461
- U. REC-SIM-630R: NEMA 6-30R Simplex Receptacle:
- 1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell HBL9330
      - 2) Leviton 5372
      - 3) Pass & Seymour 3801
      - 4) Cooper 5700N
- V. REC-SIM-650R: NEMA 6-50R Simplex Receptacle:
- 1. 250-volt, 50 amp, 2-pole, 3-wire grounding type with thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell HBL9367
      - 2) Leviton 5374
      - 3) Pass & Seymour 3804
      - 4) Cooper 5709N
- W. REC-SIM-1420R: NEMA 14-20R Simplex Receptacle:
- 1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell HBL8410
      - 2) Pass & Seymour 3820
      - 3) Cooper 5759
- X. REC-SIM-L520R: NEMA L5-20R Simplex Receptacle, Locking Type:
- 1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
    - a. Manufacturers:
      - 1) Hubbell

- 2) Leviton
- 3) Pass & Seymour L520
- 4) Cooper CWL520R

Y. REC-SIM-L530R: NEMA L5-30R Simplex Receptacle Locking Type:

- 1. 125-volt, 30 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
  - a. Manufacturers:
    - 1) Hubbell
    - 2) Leviton
    - 3) Pass & Seymour L530
    - 4) Cooper CWL530R

Z. REC-SIM-L620R: NEMA L6-20R Locking Type Simplex Receptacle:

- 1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
  - a. Manufacturers:
    - 1) Hubbell HBL2320
    - 2) Leviton 2320
    - 3) Pass & Seymour L620R
    - 4) Cooper CWL620R

AA. REC-SIM-L630R: NEMA L6-30R Locking Type Simplex Receptacle:

- 1. 250-volt, 30 amp, 2-pole, 3-wire grounding type with thermoplastic face.
  - a. Manufacturers:
    - 1) Hubbell HBL2620
    - 2) Leviton 2620
    - 3) Pass & Seymour L630R
    - 4) Cooper CWL630R

BB. REC-SIM-L1420R: NEMA L14-20R Locking Type Simplex Receptacle:

- 1. 125/250-volt, 20 amp, 3-pole, 4-wire grounding type with thermoplastic face.
  - a. Manufacturers:
    - 1) Hubbell HBL 2410
    - 2) Pass & Seymour L1420
    - 3) Cooper CWL1420R

CC. REC-SIM-XP: NEMA 5-20R Explosion Proof Simplex Receptacle:

- 1. 125-volt, 20 amp, 3-wire grounding type, Class 1, Division 1, Group C rated. Factory sealed, dead end.
  - a. Manufacturers:
    - 1) Appleton CPE1-2375

- 2) Crouse-Hinds CPS152201
- 3) Killark KRS-215-220

DD. REC-TAMP: NEMA 5-20R Tamper Resistant Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
  - a. Manufacturers:
    - 1) Hubbell BR20TR
    - 2) Leviton TBR20
    - 3) Pass & Seymour TR5362
    - 4) Cooper TRBR20
2. Decorative Grade: Provide decorative style duplex tamper resistant receptacles in public spaces where walls are finished.
  - a. Manufacturers:
    - 1) Hubbell DR20TR
    - 2) Leviton TDR20
    - 3) Pass & Seymour TR2635

EE. REC-TAMP-GFI: NEMA 5-20R GFI Tamper Resistant Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type tamper-resistant with test and reset buttons in impact resistant thermoplastic face, listed.
  - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
  - b. Manufacturers:
    - 1) Hubbell GFTR20
    - 2) Cooper TRSGF20
    - 3) Pass & Seymour 2097TR
    - 4) Leviton GFTR2

FF. REC-TAMP-QUAD: NEMA 5-20R Double Duplex Tamper Resistant Receptacle:

1. Consists of two duplex tamper resistant receptacles, double gang box, plaster ring and faceplate.
  - a. Manufacturers:
    - 1) Refer to Tamper Resistant Receptacle above.

GG. REC-QUAD-O: NEMA 5-20R Plug Load Controlled Duplex Receptacle:

1. Consists of two plug load controlled duplex receptacles, double gang box, plaster ring and faceplate.
  - a. Manufacturers:
    - 1) Refer to Plug Load Controlled Duplex Receptacle above.



- HH. REC-QUAD-IL: NEMA 5-20R Double Illuminated Face Duplex Receptacle:
1. Consists of two illuminated face duplex receptacles, double gang box, plaster ring and faceplate.
    - a. Manufacturers:
      - 1) Refer to Duplex Illuminated Face Receptacle above.
- II. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:
1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
    - a. Manufacturers:
      - 1) Refer to Duplex Receptacle above.
- JJ. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:
1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
    - a. Manufacturers:
      - 1) Refer to Duplex GFI Receptacle above.
- KK. REC-QUAD-USB: NEMA 5-20R Double Duplex USB Receptacle:
1. Consists of two duplex USB receptacles, double gang box, plaster ring and faceplate.
    - a. Manufacturers:
      - 1) Refer to USB Receptacle above.
- LL. REC-QUAD-WP: NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
1. Consists of two duplex, GFCI receptacles. Double gang box. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
    - a. Manufacturers:
      - 1) Receptacle: Refer to GFCI Receptacle above.
      - 2) Cover:
        - a) Intermatic WP1030MXD
        - b) Pass & Seymour WIUCAST2
        - c) Thomas & Betts Red Dot 2CKU
- MM. REC-XR#: 600-volt, 60 amp, 3-pole, 4-wire Locking Type Simplex Receptacle for X-ray Isolated Power Equipment:
1. Black nylon or polycarbonate face. Cast aluminum surface mounted box, 45° angle adapter, weather protective lift cover on receptacle.

a. Manufacturers:

- 1) Hubbell HBL26410-RECP/HBL26401-BOX/HBL26404-ADAPTER
- 2) Pass & Seymour 26420/26401/26404
- 3) Cooper 26420/26401/26404

- NN. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
- OO. Side wired devices shall have four binding screws that are undercut for positive wire retention.
- PP. Ground fault circuit interrupter (GFCI) receptacles shall be listed and comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.
- QQ. Isolated ground receptacles shall have the equipment ground contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from the mounting strap.
- RR. Integral surge suppression receptacles with integral surge suppression shall comply with the following:
1. Category A3 listed.
  2. Line to ground, line to neutral, and neutral to ground modes.
  3. Metal-oxide varistors with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 210 joules per mode.
  4. Status indication: Light visible in the face of the device and audible alarm to indicate device is no longer active or in service.
  5. Distinctive symbol on device face to denote SPD-type device.
  6. Device shall be blue with blue coverplate.
  7. NEMA 5-20R duplex receptacle, 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap.

a. Manufacturers:

- 1) Hubbell HBL5362SA
- 2) Leviton
- 3) Pass & Seymour
- 4) Cooper

- SS. Hazardous (Classified) location receptacles shall comply with NEMA FB 11.

## 2.5 COUNTERTOP AND FURNITURE RECEPTACLE ASSEMBLIES

- A. REC-#: Pop-up Style Receptacle Assembly Listed for Countertop Applications.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face or opposite face of assembly, gasketed countertop enclosure, UL 948 section 146 spill test. Architect to select finish from standard factory options. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation. Provide mockup installation for review and acceptance.

2. Product Specific Coordination:
  - a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
  - b. Hubbell: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.
  - c. Lew Electric: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.
  - d. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.
  
3. Manufacturers:
  - a. Hubbell RCT200
  - b. Lew Electric PUR20
  
- B. REC-#: Pop-up Style Receptacle Assembly Listed for Furniture Installation.
  1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face of assembly. Two (2) Type A USB charging rated at 5VDC 3.0A minimum. Mounted in 5"x5"x5" maximum pop-up enclosure. Architect to select finish from standard factory options.
  2. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation. Provide mockup installation for review and acceptance.
  3. Product Specific Coordination:
    - a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
    - b. Hubbell: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.
    - c. Lew Electric: Provide gfi circuit breaker for overcurrent protection device serving branch circuit.
    - d. Wiremold: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.
    - e. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.
  4. Manufacturers:
    - a. Hubbell WSUSB2X2
    - b. Wiremold DQFPUST
    - c. Lew Electric PUFFP-CT-2USB

- C. REC-#: Modular Furniture Power System Listed for Furniture Installation.
1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Three (3) NEMA 5-15R/5-20R, with both simplex devices on same face of assembly. One (1) combination Type A/Type C USB charging rated at 5VDC 3.0A minimum. Integral circuit breaker. First unit includes 10ft plug-and-cord. Daisy-chained units including a 3ft cord between devices. Refer to plans for quantity of devices required. UL 962A Spill/Splash rated. Color selection by architect based on standard factory options.
  2. Mounting: recessed in surface hardware
  3. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation. Provide mockup installation for review and acceptance.
  4. Product Specific Coordination:
    - a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.
    - b. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.
  5. Manufacturers:
    - a. Legrand Modpower Series

## 2.6 FLOOR BOXES

- A. Cover Color and Style: Verify with Architect from manufacturer standard options.
- B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.
- C. Floor Boxes Housing Material Based on Cast-in-Place Floor Type:
1. Slab on Grade: Cast Iron or listed for slab on grade with special kit, coating ,or equivalent; corrosion resistant.
  2. Elevated Slab: Cast Iron,
  3. Raised Access Floor, Cast-in-Place, or Access Floor Panels: Stamped steel.
  4. Wood Floor, not Cast-in-Place: Stamped steel and rated for wood floor application.
- D. FB-#: Concealed Center Compartment:
1. Floor Box, flush-mounted hinged cover, square/rectangular center service area with closed while-in-use cover and cable egress doors in cover, provide complete with appropriate outlet cover plates and hardware. For use with 5-inch minimum concrete pour floors, fully adjustable, UL 514 scrub water listed.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 1-inch conduit.
    - b. Voice/Data outlet with 1-inch conduit. Refer to Technology drawings for additional information.
    - c. Audio/Visual outlet with 1-1/4-inch conduit. Refer to Technology drawings for additional information.
    - d. Spare with 1-inch conduit.

3. Manufacturers:
    - a. Hubbell CFB Series
    - b. Legrand Wiremold RFB Series
    - c. ABB Steel City 664/665/667 Series
  4. Installation: Group route raceway conduits under slab on grade or in ceiling space below to nearest wall or as shown on plans. Provide provisions to core drill elevated floors and route conduits to ceiling space of associated floor box. Provide hub reducers when applicable.
- E. FB-#: Concealed Center Compartment (Fire Rated):
1. Floor Box, Fire Rated-2 hours, square/rectangular flush-mounted hinged cover, center service area with closed while-in-use cover and cable egress doors in cover, provide complete with appropriate outlet coverplates and hardware. For use with 3-1/4-inch minimum 6-1/2-inch maximum concrete pour floors, fully adjustable, UL 514 scrub water listed. Provide boxes located in elevated floors with fire rated installation kit.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 1-1/2-inch conduit.
    - b. Voice/Data outlet with 1-1/2-inch conduit. Refer to Technology drawings for additional information.
    - c. Audio/Visual outlet with 2-inch conduit. Refer to Technology drawings for additional information.
    - d. Spare with 1-inch conduit.
  3. Manufacturers:
    - a. Hubbell CFB Series
    - b. Legrand Wiremold Evolution Series
  4. Installation: Group route raceway conduits under slab on grade or in ceiling space below to nearest wall or as shown on plans. Provide provisions to core drill elevated floors and route conduits to ceiling space of associated floor box, UL 514 scrub water listed. Provide hub reducers when applicable.
- F. FB-#: Concealed Center Compartment (Access Floor):
1. Floor Box, access floor type, square/rectangular flush-mounted hinged cover, center service area with closed while-in-use cover and cable egress doors in cover, provide complete with appropriate outlet cover plates and hardware, UL 514 scrub water listed. For use in access floors systems 3/4" - 2" thick.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 1-inch conduit.
    - b. Voice/Data outlet with 1 -inch conduit. Refer to Technology drawings for additional information.
    - c. Audio/Visual outlet with 1-1/4 -inch conduit. Refer to Technology drawings for additional information.
    - d. Spare with 1- inch conduit.

3. Manufacturers:
    - a. Hubbell AFB Series
    - b. Legrand Wiremold Evolution Series
    - c. ABB Steel City AFM Series
  4. Installation: Group route raceway conduits under finished access floor to nearest wall or as shown on plans. Provide hub reducers when applicable.
- G. FB-#: Round Flush with Finished Floor:
1. Floor Box, round, round flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with 5-inch minimum concrete pour floors, fully adjustable.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
    - b. Voice/Data outlet with 3/4-inch conduit.
    - c. Audio/Visual outlet with 1-inch conduit.
    - d. Power furniture/equipment feed with flexible whip and 1-inch conduit.
    - e. Voice/Data furniture/equipment feed with flexible whip and 1-inch conduit.
    - f. Audio/Visual furniture/equipment feed with flexible whip and 1-inch conduit.
    - g. Spare with 1- inch conduit.
    - h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.
  3. Manufacturers:
    - a. Cast:
      - 1) Hubbell 2503 Series
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 600 Series
    - b. Stamped Steel:
      - 1) Hubbell B2527 Series
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 68 Series
    - c. Non-Metallic PVC:
      - 1) Hubbell PFB1 Series
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 68 HP Series
  4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Provide hub reducers when applicable.

- H. FB-#: Square or Rectangular (Standard):
1. Floor Box, square or rectangular, square/rectangular flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with 5-inch minimum concrete pour floors, fully adjustable.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
    - b. Voice/Data outlet with 3/4-inch conduit.
    - c. Audio/Visual outlet with 1-inch conduit.
    - d. Power furniture/equipment feed with flexible whip and 1-inch conduit.
    - e. Voice/Data furniture/equipment feed with flexible whip and 1-inch conduit.
    - f. Audio/Visual furniture/equipment feed with flexible whip and 1-inch conduit.
    - g. Spare with 3/4- inch conduit.
    - h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.
  3. Manufacturers:
    - a. Cast:
      - 1) Hubbell B### Series
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 640 / 840 Series
    - b. Stamped Steel:
      - 1) Hubbell 242# Series
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 740 Series
    - c. Non-Metallic PVC:
      - 1) Hubbell
      - 2) Legrand Wiremold 880 Series
      - 3) ABB Steel City 640 Series
  4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Provide hub reducers when applicable.
- I. FB-#: Square or Rectangular (Shallow):
1. Floor Box, square or rectangular, square/rectangular flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with 2-inch minimum concrete pour floors, fully adjustable.
  2. Gang / Outlet Descriptions:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle with 3/4-inch conduit.
    - b. Voice/Data outlet with 3/4-inch conduit.
    - c. Audio/Visual outlet with 1-inch conduit.
    - d. Power furniture/equipment feed with flexible whip and 3/4-inch conduit.
    - e. Voice/Data furniture/equipment feed with flexible whip and 3/4-inch conduit.

- f. Audio/Visual furniture/equipment feed with flexible whip and 3/4-inch conduit.
- g. Spare with 3/4- inch conduit.
- h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

a. Cast:

- 1) Hubbell B### Series
- 2) Legrand Wiremold 880 Series
- 3) ABB Steel City 640 / 840 Series

b. Stamped Steel:

- 1) Hubbell B243# Series
- 2) Legrand Wiremold 880 Series
- 3) ABB Steel City 740 Series

4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Provide hub reducers when applicable.

## 2.7 POKE-THROUGH FITTINGS

- A. Cover Color and Style: Verify with Architect from manufacturer standard options.
- B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.
- C. UL listed as fire-rated poke-through device for 1, 2, 4-hour rated floors: include fire stops and smoke barriers in through-floor component. UL514A listed for scrub locations.
- D. Terminate in 4-inch square by 2-1/2-inch deep junction box.
- E. Suitable for installation with a floor thickness of 2-1/4 to 7 inches.
- F. PT-#: 3" Fire Rated Poke-Through:
  - 1. Semi-flush mounted, hinged covers, for use with 3-inch core holes, provide complete with appropriate outlet coverplates and hardware. UL 514 scrub rated listed.
  - 2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to cable management system:
    - a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
    - b. Voice/Data outlet.
    - c. Audio/Visual outlet.
    - d. Power furniture/equipment feed with flexible whip.
    - e. Voice/Data furniture/equipment feed with flexible whip.
    - f. Audio/Visual furniture/equipment feed with flexible whip.
    - g. Conduit Raceway (in ceiling space below floor):
      - 1) Power: 3/4-inch conduit.



- 2) Voice/Data: 3/4-inch conduit.
- 3) Audio/Visual: 1-inch conduit.

h. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

- 1) Hubbell PT2X2
- 2) Wiremold
- 3) Thomas & Betts

G. PT-#: 4" Fire Rated Poke-Through:

1. Semi-flush mounted, hinged covers, for use with 4-inch core holes, provide complete with appropriate outlet coverplates and hardware. UL 514 scrub rated listed.

2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to cable management system:

- a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
- b. Voice/Data outlet.
- c. Audio/Visual outlet.
- d. Power furniture/equipment feed with flexible whip.
- e. Voice/Data furniture/equipment feed with flexible whip.
- f. Audio/Visual furniture/equipment feed with flexible whip.
- g. Spare.
- h. Conduit Raceway (in ceiling space below floor):
  - 1) Power: 3/4-inch conduit.
  - 2) Voice/Data: 3/4-inch conduit.
  - 3) Audio/Visual: 1-inch conduit.

i. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.

3. Manufacturers:

- a. Hubbell SystemOne Series
- b. Legrand Wiremold 4RF/RC Series
- c. ABB Steel City FPT4 Series

H. PT-#: Concealed Center Service Fire-Rated Poke-Through:

1. Semi-flush mounted, concealed service center with pass through cable covers, for use with 4 6 8 10-inch core holes, provide complete with appropriate outlet cover plates and hardware. UL 514 scrub rated listed. 2-hour fire rated.

2. Gang / Outlet Descriptions, route conduit in ceiling space of lower level. Provide provisions to core drill floor to route power circuits to panel on same floor as poke through. Route low voltage raceways to cable management system:

- a. 125 Volt, 20 amp, NEMA 5-20R duplex receptacle.
- b. Voice/Data outlet.

- c. Audio/Visual outlet.
  - d. Spare.
  - e. Conduit Raceway (in ceiling space below floor):
    - 1) Power: 3/4 -inch conduit.
    - 2) Voice/Data: 3/4-inch conduit.
    - 3) Audio/Visual: 1-inch conduit.
  - f. Refer to Technology drawings for additional information related to voice/data and audio/visual outlet requirements.
3. Manufacturers:
- a. Hubbell SystemOne Series
  - b. Legrand Wiremold Evolution Series

## 2.8 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade or refer to Details as shown on drawings.
  - 1. Body: Nylon with screw-open cable gripping jaws and provisions for attaching external cable grip.
- B. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## 2.9 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
  - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

## 2.10 CORD REELS

- A. CR-#: 50' 3#12 AWG type 'SOW-A' cord with adjustable ball stop. 120 volt, NEMA 5-20R, simplex receptacle connector, rated 16 amps continuous.
  - 1. Manufacturers:
    - a. Daniel Woodhead 92433
    - b. 9521 w/ Hubbell 5369CY
    - c. Appleton RL153L
    - d. Hubbell HBL HBL45123C20
- B. CR-#: 50' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Hand lamp with simplex 120-volt NEMA 5-15R receptacles, rated 6.5 amps.

1. Manufacturers:
  - a. Daniel Woodhead 954
  - b. 106US
  - c. Appleton
  - d. Hubbell HBL50163IN
  
- C. CR-#: 25' 3#16 AWG type 'SJOW-A' cord with adjustable ball stop. Two 120-volt NEMA 5-15R receptacles mounted in cast outlet box, rated 10 amps.
  1. Manufacturers:
    - a. Daniel Woodhead 925
    - b. Appleton RL2510
    - c. Hubbell HBLC25163C

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
  
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
  
- C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacles and electrical outlets rated 50 amps or less single-phase and 100 amps or less three-phase in the following locations, as shown on drawings, or required by adopted code:
  1. Bathrooms, locker rooms, shower rooms
  2. Kitchens' all 120-volt through 250-volt receptacles
  3. Buffet, serving, food preparation areas; all 120-volt through 250-volt receptacles
  4. Rooftops
  5. Interior/Exterior locations subject to damp/wet conditions
  6. When located within 6 feet of sinks, bathtubs, and shower stalls
  7. Plug-and-cord receptacles when the utilization appliance is located within 6 feet of a sink edge.
  8. Aquariums and bait wells
  9. Garages, accessory buildings, service bays
  10. Accessory dwelling buildings
  11. Exterior dwelling outlets (disconnects, equipment connections, etc.) when required by code.
  12. Boathouses
  13. Specific Appliances: Auto vacuum machines, water drink/bottle fill coolers, pressure staying machines, tire inflation machines, vending machines, sump pumps, dishwashers, electric ranges, ovens, clothes dryers, microwave ovens
  14. Horticultural luminaire branch circuits
  15. Future Provisions: Provide a conduit raceway and backbox for the future addition of countertop pop-receptacle when receptacles are not installed in kitchen islands and peninsulas.

- D. Arc-Fault Protection: Provide arc-fault protection for all branch circuit breakers serving the following spaces, or required by adopted code.
1. Dwelling unit living and occupied areas including but not limited to kitchens, family, dining, living, parlors, libraries, dens, bedrooms, sunrooms, recreation, closets, hallways, laundry, and similar spaces.
  2. Dormitory bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms
  3. Guest rooms and guest suites
  4. Sleeping rooms for nursing homes, limited care, and similar non-dwelling living quarters dedicated to sleeping.
- E. Tamper Resistant Protection: Provide tamper resistant protection for all 15 / 20-amp 120/208 straight blade wiring devices in the following locations, as shown on the drawings, or required by adopted code.
1. Dwelling units and accessory dwelling unit structures
  2. Boathouses
  3. Dormitory units
  4. Guest rooms, guest suites, and common public areas
  5. Childcare, preschool, elementary, middle, high school, educational facilities
  6. Medical Business Office: Offices, corridors, waiting rooms, common areas
  7. Public Buildings: Corridors, waiting rooms, common areas
  8. Public Spaces involving: Transportation waiting, gymnasiums, fitness centers, auditoriums, public use venue common areas
  9. Nursing homes, assisted living, psychiatric spaces, substance abuse, foster care facilities
  10. Agricultural buildings common areas accessible to the public
- F. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This may include X-ray or similar non-destructive means.
- G. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- H. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- J. Install devices and wall plates flush and level.
- K. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 260553 - Electrical Identification.
- L. Test receptacles and modular wiring connectors for proper polarity, ground continuity and compliance with requirements.
- M. Floor Box Installation:
1. Set boxes level and flush with finish flooring material.
  2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.
  3. Provide a minimum horizontal offset of 24 inches between boxes.

4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

END OF SECTION 262726

**SECTION 262813 - FUSES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Fuses
- B. Spare Fuse Cabinet

**1.2 REFERENCES**

- A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types
- B. UL 198E - Class R Fuses
- C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- D. NEMA FU 1 - Low Voltage Cartridge Fuses
- E. NFPA 70 - National Electrical Code (NEC)

**1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.

**1.4 EXTRA MATERIALS**

- A. Provide two fuse pullers.
- B. Provide three of each size and type of fuse installed.

**1.5 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS - FUSES**

- A. Bussman, Division of Eaton
- B. Edison Fuse, Division of Cooper Industries
- C. Mersen
- D. Littelfuse Inc

**2.2 FUSES**

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.
- D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.
- E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.
- F. Control transformer fuses: Class CC (time delay).
- G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

### **2.3 SPARE FUSE CABINET**

- A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install fuses where indicated on the drawings and specifications.
- B. Install fuses in accordance with manufacturer's instruction.
- C. Install fuses in packaged equipment as required by equipment manufacturer.
- D. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- E. Install spare fuse cabinet in the Main Electrical Room.

END OF SECTION 262813

**SECTION 262816 - DISCONNECT SWITCHES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Fusible switches
- B. Non-fusible switches
- C. Molded case circuit switches
- D. Molded case switches
- E. Motor disconnect switch
- F. Mechanically interlocked disconnect
- G. Mobile Diagnostics Service Disconnect
- H. Enclosures

**1.2 RELATED SECTIONS AND WORK**

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

**1.3 REFERENCES**

- A. NEMA KS 1 - Enclosed Switches

**1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

**1.5 COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.



## **PART 2 - PRODUCTS**

### **2.1 FUSIBLE AND NON-FUSIBLE SWITCHES**

- A. Acceptable Manufacturers:
  - 1. Square D 3110 Series
  - 2. Eaton DH Series
  - 3. ABB TH Series
  - 4. Siemens HNF / HF Series
- B. FDS-; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.
- C. DS-; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool. Handle lockable in OFF position.
- D. Enclosures: Type as indicated on the disconnect schedule.
- E. Accessories: As indicated on the Disconnect Schedule. Provide the following accessories for each application.
  - 1. Lockable
  - 2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

### **2.2 MOLDED CASE CIRCUIT BREAKERS AND SWITCHES**

- A. Acceptable Manufacturers:
  - 1. Square D
  - 2. Eaton
  - 3. ABB
  - 4. Siemens
- B. CB-; Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
  - 1. Thermal Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip settings.
  - 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time adjustments.
    - d. Ground-fault pickup level, time delay, and I<sup>2</sup>t responses.

4. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
- C. CB-; Molded Case Switches: Molded case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- D. Accessories: As indicated on the Disconnect Schedule. Provide the following accessories for each application.
1. Lockable
  2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

### **2.3 MOTOR DISCONNECT SWITCH**

- A. Acceptable Manufacturers:
1. Square D 3110 Series
  2. Eaton r5 Series
  3. ABB ML Series
  4. Siemens LBR Series
- B. Enclosures: Type as indicated on the Disconnect Schedule.
- C. Ground lug connection provided in enclosure.
- D. Accessories: As indicated on the Disconnect Schedule. Provide the following accessories for each application.
1. Lockable
  2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.
- E. Listed UL 508 suitable for motor control.

### **2.4 MECHANICALLY INTERLOCKED DISCONNECT**

- A. Acceptable Manufacturers:
1. Disconnect
    - a. Square D 3110 Series
    - b. Eaton DH Series
    - c. ABB TH Series
    - d. Siemens HF Series
  2. Receptacle
    - a. Crouse-Hinds Arktite
    - b. Appleton Powertite

- B. DSS-; Switch and Plug Assemblies: Rated for making and breaking loads, enclosed switch with externally operable interlock to prevent disconnecting receptacle with switch in ON position or inserting receptacle in ON position without a tool. Padlock lockable provision to meet OSHA lockout/tagout regulations.
- C. Enclosures: Type as indicated on the Disconnect Schedule.
- D. Ground lug connection provided in enclosure.
- E. Accessories: As indicated on the Disconnect Schedule. Provide the following accessories for each application.
  - 1. Lockable
  - 2. Matching male pin and sleeve plug, two auxiliary/pilot contacts.
  - 3. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.
- F. Listed UL 2682 suitable for motor disconnect.

## **2.5 MOBILE DIAGNOSTICS SERVICE DISCONNECT**

- A. Acceptable Manufacturers:
  - 1. Square D 3110 Series
  - 2. Eaton DH Series
  - 3. ABB TH Series
  - 4. Siemens HF Series
- B. MDSD-; Mobile Diagnostics Service Disconnect: Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position without a tool.
- C. Accessories: As indicated on the Disconnect Schedule. Provide the following accessories for each application.
  - 1. Lockable
  - 2. Provide finger safe barriers for exposed line-side terminations and energized components when the switch is in the open position.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Field coordinate installation with other contractors and equipment to maintain code required working space requirements.
- D. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

**3.2 MOBILE DIAGNOSTICS SERVICE DISCONNECT**

- A. Coordinate installation with mobile medical equipment requirements and vendor.

**3.3 ADJUSTING**

- A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION 262816

**SECTION 263213 - PACKAGED ENGINE GENERATOR SYSTEMS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Packaged engine generator system
- B. Remote radiator
- C. Heat exchanger
- D. Exhaust silencer and fittings
- E. Fuel fittings and day tank
- F. Fuel polishing system
- G. Remote annunciator panel
- H. Battery and charger
- I. Remote Fuel Fill Station (RFFS-#)
- J. Weatherproof enclosure
- K. Radiator mounted load bank

**1.2 REFERENCES**

- A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- B. ANSI/NEMA AB 1 - Molded Case Circuit Breakers
- C. ANSI/NEMA MG 1 - Motors and Generators
- D. NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines
- E. NFPA 70 - National Electrical Code (NEC)
- F. NFPA 99 - Standard for Health Care Facilities
- G. NFPA 110 - Standard for Emergency and Standby Power Systems
- H. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- I. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines
- J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the generator set, its components and the operation thereof.

**1.3 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 260500.
- B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
- C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.
  - 1. Include work clearance and equipment access information. Clearly identify required equipment access locations for installation, maintenance, testing, and repair.
- D. Submit certificates for compliance with EPA Emissions Standards for Compressed Ignition Engines.
- E. Submit manufacturer's installation instructions under provisions of Section 260500.
- F. Submit complete control and operation sequences for on-board paralleling system.
- G. Submit load study indicating the voltage drop under starting condition for the fire pumps will not exceed 15%. Fire pump shall be the last step on the generator.

**1.4 EXTRA MATERIALS**

- A. Submit maintenance materials under provisions of Section 260500.
- B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.
- C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system. Provide additional fuel polishing filters for one year of operation.
- D. Provide one fuse for every type and rating used.
- E. Provide five (5) extra DC incandescent lamps and five (5) compact fluorescent lamps.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site under provisions of Section 260500.
- B. Store and protect products under provisions of Section 260500.
- C. Accept packaged engine generator set and accessories on site in crates and verify damage.
- D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

**1.6 SYSTEM DESCRIPTION**

- A. Engine generator system to provide source of emergency and standby power.

- B. System Capacity: 275 KW, 344 KVA, 344 starting KVA at specified voltage dip, at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; continuous rating using engine-mounted radiator.
- C. Emergency Power Supply System (EPSS) shall be NFPA 110 Type 10 Class 24 Level 2.
- D. Operation: In accordance with ANSI/NFPA 110.

### **1.7 COORDINATION DRAWINGS**

- A. Reference Coordination Drawings article in Section 260500 for required generator electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in 1/4" scale plan of room.

### **1.8 PROJECT RECORD DOCUMENTS**

- A. Submit record documents under provisions of Section 260500.
- B. Accurately record location of engine generator and mechanical and electrical connections.

### **1.9 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data under provisions of Section 260500.
- B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

### **1.10 QUALIFICATIONS**

- A. Manufacturer: Company specializing in packaged engine generator system with minimum five (5) years documented experience.
- B. Manufacturer: Company with minimum five (5) years of documented on-board paralleling system experience.
- C. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 50 miles of the project site.

### **1.11 WARRANTY**

- A. Provide a ten (10) year warranty under provisions of Section 260500.

### **1.12 MAINTENANCE SERVICE**

- A. Furnish service and maintenance of packaged engine generator system for one (1) year from Date of Substantial Completion. Maintenance service shall be performed by skilled employees of manufacturer's designated service organization. Include quarterly exercising, and routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts, supplies, and labor.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Caterpillar.
- B. Cummins Power Generation.
- C. Kohler.
- D. MTU On Site Energy.
- E. GE Waukesha.

**2.2 PACKAGED ENGINE-GENERATOR SET (GEN-#)**

- A. Packaged engine-generator set shall be a coordinated assembly of compatible components. Stationary generators shall be listed.
- B. Safety Standard: Comply with ASME B15.1 and UL 2200.
- C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.
- D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.
- E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.
- F. Maximum Dimensions:
  - 1. Base Bid: 190" L x 60" W x 134" H.
  - 2. Alternate Bid: 300" L x 96" W x 138" H.

**2.3 ENGINE**

- A. Type: Water-cooled in-line or V-type, four-stroke cycle spark-ignition compression ignition diesel electric ignition internal combustion engine.
- B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.
- C. Fuel: Appropriate for use of No. 2 fuel oil natural gas B10 biodiesel.
- D. Engine Speed: 1200 1800 RPM.
- E. Governor: Isochronous type with speed sensing.



- F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- G. Frequency Response:
1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.
- H. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve.
- I. Fuel Supply System:
1. Base-Mounted Fuel Tank: UL 2085 listed fuel tank with 24 hour rated (NFPA 110 minimum run time by class) capacity. Integral rupture basin with leak detection. Provide fueling port with an overflow prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors lockable cover, and analog level gauge. Furnish complete with float switches to indicate low 25% 50% and 75% fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.
  2. Fuel Cooler: Provide unit-mounted fuel cooler with all required hoses, fittings and mounting hardware. Generators without a unit-mounted radiator shall have an integral fan powered by a 120V circuit.
- J. Fuel Polishing System:
1. Fuel polishing system capable of removing 99% of emulsified water and particulate down to 3 microns from the fuel. The system shall be sized so the stored fuel capacity shall be polished at least once per week. The system shall include a pump to circulate the fuel from the storage tank through the filter/separator and return it to the tank, A gauge or alarm shall provide notification when a filter is due for change. A timer shall be set to run the pump during off peak hours.
- K. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.
- L. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 120 208-1Ø volts AC. The minimum wattage of the heater shall be watts or as recommended by the manufacturer.
- M. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
1. GRR; Remote Radiator: Vertical air discharge. Multiple belt drive from totally enclosed sealed bearing motor. Sized by generator manufacturer.
  2. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.
  3. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.

4. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.
- N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:
1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.
  2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.
  3. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.
  4. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
  5. Provide two battery strings, two DC power supply/chargers with monitoring, and a best battery selector system. Each shall be sized to provide total starting capacity.
  6. DC Power Supply/Charger: Utility grade current limiting type with battery temperature compensation designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave filtered rectifier, digital DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
  7. Best battery selector system for dual battery single load configuration. Solid-state design must isolate battery strings from each other.
- O. Exhaust System: Critical type silencer (85 dBA max at 10 feet) Industrial type silencer (20 to 75 Hz frequency range; 87 dBA max at 25 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of 3/4" drain line. Opening shall be flush on inside of silencer.
- P. The packaged engine generator shall comply with the current Environmental Protection Agency EPA Emissions standards.
- Q. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.
- R. Mounting: Provide unit with suitable spring-type vibration isolators.
- 2.4 GENERATOR**
- A. Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.
  - B. Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.
  - C. Insulation: ANSI/NEMA MG 1, Class F.
  - D. Temperature Rise: 105°C 80°C continuous.

- E. Enclosure: ANSI/NEMA MG 1; open drip-proof.
- F. Voltage Regulation:
  1. The maximum instantaneous voltage dip (IVD) shall be 28 percent.
  2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation  $\pm 1$  percent from no load to full load. Include manual controls to adjust voltage drop  $\pm 5$  percent voltage level, and voltage gain.
- G. Subtransient Reactance (X'd): Maximum 15 percent.
- H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

## 2.5 CONTROLS AND INDICATION

- A. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- B. Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.
  1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.
- C. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
  1. Alarm indication as required by NFPA 110 for a Level 2 system.
  2. AC frequency meter.
  3. AC output voltmeter with phase selector switch.
  4. AC output ammeter with phase selector switch.
  5. Output voltage adjustment.
  6. DC voltmeter (alternator battery charging).
  7. Engine start/stop selector switch.
  8. Engine running time meter.
  9. Oil pressure gauge.
  10. Engine coolant temperature gauge.
  11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
  12. Fuel derangement alarm.
  13. Generator overload.
  14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
  15. Remote Alarm Contacts: Pre-wire SPST contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
  16. Ground fault indication.
  17. Generator control and start signal failure.
  18. On-board paralleling controls.

19. 80% load alarm.
  20. Key switch, three-position selection switch.
- D. GAP-#; Remote Engine Annunciator Panel: ANSI/NFPA 99 and NFPA 110 for a Level 2 system. Include the listed pre-alarm and alarm points, audible alarm, alarm silencing means, repetitive alarm circuitry, and lamp test switch in a surface mounted panel with color painted finish. Provide all interconnecting wiring in conduit per manufacturer's requirements by the Electrical Contractor. The remotely reported alarms shall include the following.
1. Overcrank
  2. Low water (engine) temperature
  3. High engine temperature pre-alarm
  4. High engine temperature
  5. Low lube oil pressure pre-alarm
  6. Low lube oil pressure
  7. Overspeed
  8. Low fuel main tank
  9. Low coolant level
  10. Not in auto
  11. Emergency Power Supply (EPS) supplying load
  12. High battery voltage
  13. Low battery voltage
  14. Battery charger failure (includes AC failure)
  15. Generator running
  16. Normal utility power
  17. Emergency stop
  18. Rupture basin alarm
  19. Emergency Power Off Switch activated (EPO)
  20. Alarm for power supply or UPS serving motorized breakers
  21. Generator control and start signal failure.
  22. On-board paralleling controls.
  23. 80% load alarm.
- E. Remote Engine Manual Start Control: Two-wire remote start control from fire command center. Provide all interconnecting wiring in conduit per manufacturer's requirements (by the Electrical Contractor).
- F. Building Automation System Integration:
1. Provide a terminal block to allow the Facility Monitoring and Control System (FMCS) to report generator alarms. Provide individual terminal points for each of the annunciator alarms and pre-alarms. Provide an additional terminal point to combine all generator alarms under a single terminal point. Provide a permanent label for each terminal point. Each terminal will provide a binary output for the FMCS to read. Refer to Section 230900 for alarms reported by the FMCS.

## 2.6 ACCESSORIES

- A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic type; 100% rated breaker complying with NEMA AB1 and UL 489. The disconnect shall simultaneously open all associated ungrounded conductors and be lockable in the open position.
1. Tripping Characteristic: Designed specifically for generator protection.
  2. Trip Rating: Matched to generator rating.

3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.
  4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
  5. The disconnecting means shall also shut down the prime mover, disable all start control circuits, and be configured with a mechanical reset.
  6. Arc Energy Reduction: Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
- B. EPO; Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.
1. The Remote Manual Stop Station may be located within the generator enclosure when allowed by code. Provide an engraved plastic nameplate "EMERGENCY DISCONNECT - define location", red background, white letters, minimum 4" letters. Provide one nameplate on each side of the generator enclosure with accessible doors.
- C. Dual Source Fuel Filter:
1. High volume, selectable dual path, minimum two high-capacity filters, with water separation, and remote monitor / alarm.
  2. Operation Functionality: Selectable path, primary and standby filter. Ability to switch between filters, replace filters, and bleed filters during generator operation.
  3. Remote monitor / alarm feature wired to generator control and annunciator panel.
- D. Provide dual redundant engine starters. The redundant engine starters shall be configured to start the engine when the primary engine starter fails.

## 2.7 OUTDOOR GENERATOR-SET ENCLOSURE SKIN-TIGHT

- A. Prefabricated or pre-engineered skintight enclosure with the following features:
1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components, including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.
  2. The generator control panel shall be located no greater than 5'-0" above finished grade for ease of access.
  3. Structural Design and Anchorage: Wind resistant up to 100 mph.
  4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays. Louvers shall not extend outside main generator enclosure.
  5. Hinged Doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.

6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.
7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5'-0" above finished grade.
9. The exhaust system silencer shall be installed within the enclosure housing.
10. Acoustical Treatment: Provide acoustical treatment of the generator enclosure including wall panels, intake and exhaust air paths, ventilation openings, and tailpipe exhaust. Maximum sound level horizontally from the generator set shall be 75 dBA at 23 feet in a hemispherical free field in the configuration shown on the drawings. Sound attenuators shall be concealed within the enclosure panels. Panels shall extend from the enclosure base frame to the height of the generator section.
11. Acoustical Treatment: Provide all acoustical treatment required to conform to Title 35, Subtitle H for daytime hours. Noise levels shall include enclosure and tailpipe noise. Sound attenuators shall be concealed within the enclosure.
  - a. Generator Site: Class A Land-Based Classification Standards.
  - b. Adjacent Property: Class A Land-Based Classification Standards.

## 2.8 OUTDOOR GENERATOR-SET ENCLOSURE WALK-IN

- A. Prefabricated or pre-engineered walk-in enclosure with the following features:
  1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Construction shall allow access to control panels and service points.
  2. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.
  3. Structural Design and Anchorage: Wind resistant up to 100 mph.
  4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays. Louvers shall not extend outside main generator enclosure.
  5. Hinged doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.
  6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.
  7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
  8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5'-0" above finished grade.
  9. The exhaust system silencer shall be installed within the enclosure housing.
  10. Electrical:
    - a. A 100-amp, 3 phase, 4 wire 208/120-volt panelboard shall be factory furnished and installed. Panel shall include circuit breakers for all non-life safety electrical loads.
    - b. Provide electric unit heater inside enclosure with adjustable thermostat and disconnect switch. Heater shall maintain a minimum interior temperature of 40 °F.

- c. Provide conduit and wiring for all non-life safety loads: unit heater, engine jacket water heater, battery charger, louver motors, non-life safety lights, receptacles, etc.
  - d. Provide life safety devices (1/3 of the fluorescent vapor tight lights, light switches, 1/2 of the receptacles and emergency lighting units), conduit and wiring to a single junction box for connection to life safety circuit by electrical contractor. Emergency receptacles and switches shall be red.
  - e. Lighting shall be compact fluorescent vapor tight units with cold weather ballasts. Lighting shall allow for a uniform light level of (30) footcandles minimum on work surfaces. Normal and life safety lights shall be light switched separately. Provide two incandescent emergency lights connected to the generator starting batteries.
11. Acoustical Treatment: Provide acoustical treatment of the generator enclosure including wall panels, intake and exhaust air paths, ventilation openings, and tailpipe exhaust. Maximum sound level horizontally from the generator set shall be 75 dBA at 23 feet in a hemispherical free field in the configuration shown on the drawings. Sound attenuators shall be concealed within the enclosure panels. Panels shall extend from the enclosure base frame to the height of the generator section.
12. Acoustical Treatment: Provide all acoustical treatment required to conform to Illinois Administrative Code, Title 35, Subtitle H: NOISE for daytime nighttime hours. Noise levels shall include enclosure and tailpipe noise. Sound attenuators shall be concealed within the enclosure panels. Panels shall extend from the enclosure base frame to the height of the generator section.
- a. Generator Site: Class A Land-Based Classification Standards.
  - b. Adjacent Property: Class A Land-Based Classification Standards.
13. Manufacturers:
- a. Robinson Enclosures
  - b. Lectrus/DTS
  - c. International Supply Co. (ISCO)
  - d. Chillicothe Metal Co.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that surfaces are ready to receive work and field dimensions are as shown on the drawings.
- B. Verify that required utilities are available in proper location and ready for use.
- C. Beginning of installation means installer accepts existing conditions.

#### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install remote manual stop station in location shown on plans. Provide 120 Volt power and wiring in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams. The remote manual stop station shall shunt trip the generator mounted circuit breaker and signal the engine prime mover to stop.

- C. The A-B-C phase rotation of the generator source shall match the A-B-C phase rotation of the utility source. The Contractor shall verify the generator and utility phase rotation match to prevent three phase motors and similar loads from operating backwards while being served by the generator.

### 3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 260500 and in compliance with NFPA 110 requirements.
- B. Provide portable test bank for full load test, if required. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.
- C. Fill fuel tank prior to start of test.
- D. The on-site installation test shall be conducted as follows:
  1. With the prime mover in a "cold start" condition and the emergency load at standard operating level, a primary power failure shall be initiated by opening all switches or breakers supplying the primary power to the building or facility.
  2. The test load shall be that load that is served by the Emergency Power Supply System (EPSS).
  3. The time delay on start shall be observed and recorded.
  4. The cranking time until the prime mover starts and runs shall be observed and recorded.
  5. The time taken to reach operating speed shall be observed and recorded.
  6. The voltage and frequency overshoot shall be recorded.
  7. The time delay on transfer to emergency power for each switch shall be recorded. Life safety and critical branch transfer switches must transfer within 10 seconds.
  8. The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
  9. The voltage, frequency, and amperes shall be recorded.
  10. The prime mover oil pressure and water temperature shall be recorded, where applicable.
  11. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.
  12. When primary power is returned to the building or facility, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.
  13. The time delay on the prime mover cool down period and shutdown shall be recorded.
  14. Allow prime mover to cool for 5 minutes.
  15. A load shall be applied for 4 hours total. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate rating of the Emergency Power Supply (EPS), less applicable derating factors for site conditions. Observe and record load changes and the resultant effect on voltage and frequency.
  16. The full load test shall be initiated immediately after the cooling time has expired by any method that starts the prime mover and, immediately upon reaching rated rpm, picks up 100 percent of the nameplate kW rating on one step, less applicable derating factors for site conditions.
  17. During test, record the following at 5-minute intervals for the first 15 minutes and every 15 minutes for the rest of the test:
    - a. Kilowatts
    - b. Amperes
    - c. Voltage
    - d. Frequency



- e. Coolant temperature
  - f. Enclosure temperature (interior)
  - g. Oil pressure
  - h. Engine exhaust temperature
  - i. Engine inlet temperature
  - j. Oil Temperature
  - k. Battery charge rate
18. Upon completion of the test and after a cool down period, the crank/rest cycle shall be tested.
- a. Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.
  - b. The control switch shall be set at "run" to cause the prime mover to crank.
  - c. The complete crank/rest cycle shall be observed and recorded.
19. Test alarm and shutdown circuits by simulating conditions.
- E. Contractor shall fill fuel tanks upon completion of test.
- F. Testing documentation shall be submitted to the Architect/Engineer for review and approval. Reviewed documentation shall be submitted to IDPH as part of the project close-out certification package.
- G. Generator testing worksheets are included with this specification section.

### **3.4 MANUFACTURER'S FIELD SERVICES**

- A. Prepare, start, test, and adjust systems under provisions of Section 260500.
- B. Provide UL field inspection of generator.

### **3.5 COMMISSIONING: ON-BOARD GENERATOR PARALLELING CONTROL**

- A. Prepare, start, test, and adjust systems under provisions of Section 260500. The on-board paralleling startup, testing, and commissioning may be conducted with other startup, testing, and commissioning requirements of this specification.
- B. Provide on-site manufacturer representative for on-board generator paralleling system startup, testing, and commissioning.
- C. Simulate a utility power loss test of the EPSS and on-board generator paralleling control system.
  - 1. Refer to the emergency power system sequence of operation schedule on the drawings.
  - 2. Report and document deviations from the sequence of operation schedule, system adjustments, and deficiencies.
  - 3. Obtain and Submit Authority Having Jurisdiction AHJ observation and certificate of acceptable emergency power system operation when required for facility occupancy certificate.

### **3.6 ADJUSTING**

- A. Adjust generator output voltage and engine speed.

**3.7 CLEANING**

- A. Clean work under provisions of Section 260500.
- B. Clean engine and generator surfaces. Replace oil and fuel filters.

**3.8 DEMONSTRATION**

- A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner and Architect/Engineer.
- B. Describe loads connected to emergency and standby systems and restrictions for future load additions.
- C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

END OF SECTION 263213

**SECTION 263600 - TRANSFER SWITCH****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Automatic transfer switch with delayed transition
- B. Automatic transfer switch with delayed transition and bypass/isolation switch
- C. Portable generator and load bank connection cabinet (GCC-#)
- D. Manual transfer switch
- E. Static transfer switch
- F. Remote annunciator for ATS

**1.2 RELATED SECTIONS AND WORK**

- A. Refer to the Transfer Switch Schedule for rating and configuration.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in automatic transfer equipment with three (3) years documented experience.

**1.4 REFERENCES**

- A. NEMA ICS 1 - General Standards for Industrial Control and Systems
- B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
- C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- D. NEMA ICS 10 - Guide to Application of Low-Voltage Automatic Transfer Switch Equipment
- E. UL 1008 - Standard for Automatic Transfer Switches
- F. NFPA 99 - Health Care Code
- G. NFPA 110 - Standard for Emergency and Standby Power Systems

**1.5 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 260500.
- B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.
- C. Submit manufacturer's installation instructions under provisions of Section 260500.

**1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data under provisions of Section 260500.
- B. Include instructions for operating equipment.
- C. Include instructions for operating equipment under emergency conditions when engine generator is running.
- D. Identify operating limits which may result in hazardous or unsafe conditions.
- E. Document ratings of equipment and each major component.
- F. Include routine preventive maintenance and lubrication schedule.
- G. List special tools, maintenance materials, and replacement parts.

**1.7 REGULATORY REQUIREMENTS**

- A. Conform to applicable code for emergency and standby electrical systems.

**PART 2 - PRODUCTS****2.1 AUTOMATIC TRANSFER SWITCH WITH DELAYED TRANSITION**

- A. Automatic transfer switch, microprocessor controlled, three-position switch mechanism, delayed transition and load shed capable, with local manual operation.
- B. Acceptable Manufacturers, Standard Grade:
  - 1. Schneider Electric ASCO 300 Series
  - 2. Siemens Russelectric RMT Series
  - 3. ABB Zenith ZTG Series
  - 4. Caterpillar CTG Series
  - 5. Cummins OTPC Series
  - 6. Kohler KCS Series
- C. Description: NEMA ICS 2; automatic transfer switch.
- D. Configuration: Electrically-operated, three-position delayed transition / off capable, mechanically-held transfer switch.
- E. Control panel shall be micro-processor based.

**2.2 AUTOMATIC TRANSFER WITH DELAYED TRANSITION AND BYPASS/ISOLATION SWITCH**

- A. Automatic transfer switch, microprocessor controlled, three-position switch mechanism with bypass isolation, delayed transition and load shed capable, with local manual operation.
- B. Acceptable Manufacturers:
  - 1. Schneider Electric ASCO 7ATB Series
  - 2. Siemens Russelectric RTB Series

3. ABB Zenith ZBTS / ZBTE Series
  4. Caterpillar CBTS Series
  5. Cummins BPTC Series
- C. Description: NEMA ICS 2; automatic transfer switch with center position delayed transition / off and manual bypass switch.
- D. Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, and DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch.
- E. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

### **2.3 PORTABLE GENERATOR / LOAD BANK CONNECTION CABINET (GCC)**

- A. Acceptable Manufacturers:
1. Foxfab FFCC Series
  2. Berthold Electric Co
  3. Power Temp Systems Inc
  4. ESL Power Systems Triple Switch Series
  5. Trystar
- B. Wall mount, powder coat painted NEMA 3R housing with lockable door, 600 amps, 600 volt. This size is a part of base bid. Wall mount, powder coat painted NEMA 3R housing with lockable door, 1200 amps, 600 volt. This size is a part of alternate bid #3. Color-coded cam-lock connectors. Submit product data and dimensioned drawings. Color selection by Architect.
1. Load Bank Cam Lock Receptacle: Female plug, male cable
  2. Portable Generator Cam Lock Receptacle: Male plug, female cable
  3. Cam Lock Configuration: Power flow from female to male; note ground / neutral configurations are opposite of phase conductors at the same connection location.
- C. Interlock: Provide a kirk key or mechanical interlock between the permanent generator and the temporary generator disconnect.
- D. Three-way Manual Transfer Switch: Provide three-way switch to allow flexible connection between; onsite generator and load bank, portable generator and load, onsite generator and load. The switches may be transfer switch or circuit breaker technology.
- E. Accessories: Provide the following required accessories.
1. Generator Start Signals: Provide parallel generator start cabling from the transfer switches to the portable generator cabinet. Provide quick connect type connections for the generator start signals.
  2. Indicators:
    - a. Generator "ON" indicator
    - b. Utility "ON" indicator
    - c. Phase Monitor: A-B-C phase rotation monitor indicator.
    - d. Cabinet Heater: Provide cabinet heater with thermostat/humidistat sized per manufacturer recommendations to prevent condensation inside cabinet. EC to provide branch circuit wiring per approved shop drawings.

- F. Provide engraved plastic label including:
1. System voltage
  2. Maximum amps
  3. Short Circuit Current Rating SCCR
  4. Phase rotation direction
  5. Phase, ungrounded conductor, and grounding identification

## 2.4 MANUAL TRANSFER SWITCH

- A. Acceptable Manufacturers:
1. ASCO 300 Series
  2. Russelectric RMT Series
  3. ABB Zenith ZTG Series
  4. Cummins OTPC Series
  5. Generac W Series
  6. Kohler KCS Series
- B. Description: NEMA ICS2; manual transfer switch.
- C. Configuration: Manually-operated, three-position center-off transfer switch.
- D. Engine start switch.

## 2.5 STATIC TRANSFER SWITCH

- A. Automatic transfer switch, microprocessor controlled, solid-state electrically operated, switch mechanism, delayed transition and load shed capable, with local manual operation.
- B. Manufacturers:
1. Schneider Electric MGE Upsilon Series
  2. Eaton WaveStart TFA Series
  3. ABB Zenith STS Series
- C. Description: N+EMA PE1; Uninterruptible Power Systems.
- D. Configuration: Electronically-operated solid state switch.

## 2.6 SERVICE CONDITIONS

- A. Service Conditions: NEMA ICS 1. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

## 2.7 RATINGS

- A. Refer to the electrical diagrams for the Withstand and Close Ratings WCR available interrupting capacity (AIC) at the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two Short Circuit Current Ratings SCCR values when the SCCR rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.
- B. Series rating with upstream devices shall be allowed per UL-1008.

## 2.8 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
- G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

## 2.9 ENCLOSURE

- A. Enclosure: NEMA ICS 6; Type 1.
- B. Maximum Dimensions: 48 "L x 19 "W x 60 "H.

## 2.10 ACCESSORIES

- A. Load Shed:
  - 1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under- frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.
  - 2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.
  - 3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.
- B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.
- C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.
- D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.
- E. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.
- F. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

- G. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.
- H. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.
- I. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.
- J. Engine Exerciser: Start engine every 14 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.
- K. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.
- L. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:
1. Normal source available.
  2. Emergency source available.
  3. Exercise mode in operation.
- M. Serial Communication Port: Two twisted pairs of shielded communication cable in conduit shall daisy chain all transfer switches with a remote annunciator.
- N. RA-ATS Remote Annunciator: A remote annunciator shall be provided that shall monitor and control the following functions for each transfer switch:
1. Load Connect to Emergency/Normal Indication
  2. Source Available: Emergency/Normal Indication
  3. Time Delay Indication and Key Locked Bypass Switch
  4. Transfer Test Indication and Key Locked Switch
  5. Remote transfer loads between normal and emergency sources with Key Locked Switch
  6. Remote generator start with Key Locked Switch
  7. Remote generator stop with Key Locked Switch
- O. Annunciators shall be located where shown on the drawings, as directed by the Owner. Extend conduit and wire as required by the manufacturer.
- P. Metering Capabilities: The following metered readings shall be available at the local display. The metering information shall also be shared by serial connection to the master control cubicle of the emergency power paralleling equipment.
1. Current, per phase RMS and neutral
  2. Current unbalance %
  3. Voltage, phase-to-phase and phase-to-neutral
  4. Voltage unbalance %
  5. Real power (KW), per phase and 3-phase total
  6. Apparent power (KVA), per phase and 3-phase total
  7. Reactive power (KVAR), per phase and 3-phase total
  8. Power factor, 3-phase total & per phase
  9. Frequency
  10. Accumulated energy, (KWH, KVAH, and KVARH)
  11. Demand, (KWH, KVA)



**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as instructed by the manufacturer.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means acceptance of existing conditions.

**3.2 CONTROL AND SIGNAL CABLING**

- A. Provide control and signal cabling per manufacturer recommendations for the following systems components:
  - 1. Remote annunciator.
  - 2. Elevator controller. Provide wiring to elevator controller for emergency source mode and emergency to normal pre-signal.
  - 3. Generator start signal. The generator start signal cabling for the following transfer switches shall be fire protected for a minimum of 2 hours using an approved method:
    - a. Fire pump transfer switch
    - b. Emergency, legally required, optional standby transfer switches
    - c. Approved Methods:
      - 1) Raceway or cable encased in a minimum of 2 inches of concrete cover.
      - 2) Listed fire resistive raceway / cable system.
      - 3) Raceway / cable is protected by a listed electrical circuit protective system.

**3.3 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

END OF SECTION 263600

**SECTION 264300 - SURGE PROTECTION DEVICES****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment, distribution panels, electronic equipment, elevators, and receptacle devices.

**1.2 QUALITY ASSURANCE**

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

**1.3 REFERENCES**

- A. ANSI/IEEE C62.33 - IEEE Guide on Testing of MOV components
- B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components
- C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
- E. ANSI/UL 1449 Latest Edition - UL Standard for Safety for Surge Protective Devices
- F. CBEMA - Computer Business Equipment Manufacturers Association
- G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage
- H. NFPA 70 - National Electrical Code (NEC)
- I. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors
- J. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)
- K. UL 248-1 - Fusing
- L. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

#### 1.4 SUBMITTALS

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.
- B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

#### 1.5 SPARE PARTS

- A. Surge Protection Modules: Furnish 1 replacement module for each type installed.
- B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

#### 1.6 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
  - 1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
  - 2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
  - 3. A single 8 x 20 $\mu$ s waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- B. Minimum Repetitive Surge Current Capacity:
  - 1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
  - 2. Minimum Repetitive Surge Current Capacity Test:
    - a. An initial UL 1449 surge defined as 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
    - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50 $\mu$ s 10kV or 20kV open circuit voltage waveform and an 8 x 20 $\mu$ s 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
    - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
  - 3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
  - 4. Proof of such testing shall be the test log generated by the surge generator.

- C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.
- D. Warranty: Ten (10) years. Includes workmanship, installation and programming.
- E. No scheduled parts replacement or preventative maintenance shall be required.

## **PART 2 - PRODUCTS**

### **2.1 DESCRIPTION**

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.
- B. Short Circuit Current Rating: Provide factory label for SCCR rating. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

### **2.2 RATINGS**

- A. SPD-; Service Entrance Suppressors:
  1. For 277/480-volt, 3 phase, 4 wire, type 2, category C3 unit.
    - a. Surge current capacity: 80,000/160,000 100,000/200,000 amps per protection mode/phase
    - b. Nominal Discharge Current: 20 kA.
    - c. Mounting: Refer to the drawings.
    - d. Voltage Protection Rating: Refer to requirements below.
    - e. Components: Minimum component size of 20mm thermally protected metal oxide varistors (MOV).
    - f. Disconnect: Surge-rated disconnect with 200,000 SCCR.
  2. Manufacturers:
    - a. Square D Surgellogic EMA Series
    - b. Siemens TPS3 Series
    - c. Eaton SPD Series
    - d. Current Technology Current Guard Plus
    - e. ASCO Power Technologies 400 Series
    - f. LEA International LSS Series
- B. SPD-; Service Entrance Suppressors - Hybrid:
  1. For 277/480-volt, 3 phase, 4 wire, type 2, category C3 unit.
    - a. Surge current capacity: 100,000/200,000 120,000/240,000 amps per protection mode/phase
    - b. Nominal Discharge Current ( $I_N$ ): 20 kA.
    - c. Mounting: Refer to the drawings.
    - d. Voltage Protection Rating: Refer to requirements below.

- e. Components: Minimum component size of modular 20mm thermally protected metal oxide varistors (MOV). Modular hybrid combination of 20mm MOV may be combined with silicon avalanche diodes (SAD) or selenium cells.]
2. Manufacturers:
    - a. Current Technology SL3 Series
    - b. ASCO Power Technologies 570 Series
    - c. LEA International DS Series
- C. SPD- Secondary Distribution Suppressors:
1. For 120/208-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
    - a. Surge current capacity: 60,000/120,000 100,000/200,000 amps per protection mode/phase
    - b. Nominal Discharge Current ( $I_N$ ): 20 kA.
    - c. Mounting: Refer to the drawings.
    - d. Voltage Protection Rating: Refer to requirements below.
    - e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).
  2. Manufacturers:
    - a. Square D Surgelogic EMA Series
    - b. Siemens TPS3 Series
    - c. Eaton SPD Series
    - d. Current Technology Current Guard Plus
    - e. ASCO Power Technologies 400 Series
    - f. LEA International CFS Series
- D. SPD-; Secondary Distribution Suppressors - Hybrid:
1. For 120/208-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
    - a. Surge current capacity: 60,000/120,000 100,000/200,000 amps per protection mode/phase.
    - b. Nominal Discharge Current ( $I_N$ ): 20 kA.
    - c. Mounting: Refer to the drawings.
    - d. Voltage Protection Rating: Refer to requirements below.
    - e. Components: Minimum component size of modular 20mm thermally protected metal oxide varistors (MOV). Modular hybrid combination of 20mm MOV may be combined with silicon avalanche diodes (SAD) or selenium cells.
  2. Manufacturers:
    - a. Square D Surgelogic EMA Series
    - b. Siemens TPS3 Series
    - c. Eaton CPS Series
    - d. Current Technology SEL Series
    - e. ASCO Power Technologies 570 Series
    - f. LEA International DS Series

E. SPD-; Critical Load Protection - Fixed Equipment:

1. For 120-volt, 1 phase, 3 wire, type 3, category A3 unit.
  - a. Surge Current Capacity ( $I_N$ ): 15,000 amps per protection phase
  - b. Mounting: External, NEMA 1 enclosure
  - c. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.
  - d. Protection Modes and UL 1449 Clamping Voltage: 700 volt L-N, L-G, and 900 volt N-G.
2. Manufacturers:
  - a. Square D
  - b. Siemens
  - c. Eaton
  - d. Current Technologies
  - e. ASCO Power Technologies
  - f. LEA International
  - g. Mersen
  - h. Or approved equal

F. SPD-; Critical Load Protections - Fixed Equipment - DIN Rail Mount:

1. For 277/480 volt, 3 phase, type 2 unit. Refer to schedule or equipment requirements for specific equipment configuration required.
2. For plug-in modules to mount on DIN rail in control panels, motor control centers, etc.:
  - a. Surge Current Capacity: 25,000/50,000 amps per protection mode/phase
  - b. Nominal Discharge Current ( $I_N$ ): 20 kA
  - c. Components: Metal oxide varistors (MOV)
3. Manufacturers:
  - a. General Electric TD Series
  - b. Bussman BSP Series
  - c. ASCO Power Technologies 318 Series
  - d. Mersen Surge Trap Series
  - e. Or approved equal

G. Receptacles:

1. For 120-volt, 1 phase, 3 wire, type 3, category A3 unit.
  - a. Surge current capacity ( $I_N$ ): 12,000 amps per protection mode.
  - b. Components: 20mm MOV
  - c. Maximum Continuous Operating Voltage: 150 Volts
2. Refer to Specification Section 262726 for additional receptacle construction information.

H. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).

- a. 277/480 Volt, 3 phase, 4 wire. 1200 Volt L-N, L-G, N-G and 1800 Volt L-L
- b. 480 Volt, 3 phase, 3 wire. 2000 Volt L-G, L-L
- c. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L
- d. 240 Volt, 3 phase, 3 wire. 1200 Volt L-G, L-L
- e. 120/240 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

I. EMI/RFI Noise Rejection or Filtering:

- 1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

J. Indication:

- 1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
- 2. Each unit shall include a visual indicator that indicates the unit is functioning properly and providing protection.
- 3. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
- 4. Provide each service entrance secondary distribution and critical load type unit(s) with a transient counter.
- 5. Each unit shall contain form "C" contacts for remote indication of an alarm status.

K. Fuses:

- 1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
- 2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

### **3.2 INSTALLATION**

A. Mounting Location:

- 1. The unit shall be installed as close as practical to the panel and transformer secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the transformer or switchboard or panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.
- 2. Integral surge protection devices mount between the main and branch circuit breakers.
- 3. If internal surge protection device is specified, device shall be installed in a barrier compartment isolated from other components.

## B. Connections:

1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard or be equipped with a factory supplied integral fused switch or circuit breaker. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

## C. Additional Locations: Critical Load Protection - Fixed Equipment (120 Vac):

1. Install an A3 hard-wired surge protection device between each of the following equipment items and its power supply conductors.
  - a. Fire alarm master panel
  - b. Phone switch
  - c. Building management system master
  - d. Security system master
  - e. Telephone switch
  - f. TV head

## D. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION 264300



**SECTION 265119 - LED LIGHTING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories
- C. Light-emitting diode (LED) luminaire systems
- D. LED emergency lighting units
- E. Emergency exit signs
- F. Emergency inverter for LED light engines (individual luminaires - integral)
- G. Lighting poles

**1.2 RELATED SECTIONS**

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
  - 1. 26 09 33 Lighting Control Systems
    - a. Automatic load control relay (ALCR) (individual luminaire - integral) (ALCR3)
  - 2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

**1.3 REFERENCES**

- A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
- B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement
- C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
- D. NFPA 70E - National Electrical Safety Code
- E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System
- F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

- G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED
- I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)
- J. UL 924 - Standard for Emergency Lighting and Power Equipment
- K. UL676 Standard for Underwater Luminaires and Submersible Junction Box
- L. Project site classification as defined in IESNA RP-33 LZ2.

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 260500.
- B. Basic Requirements of Submittal:
  1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
  2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
  3. Include outline drawings, support points, weights, and accessory information for each luminaire.
  4. Submit manufacturer origin of LED chipset and driver.
- C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):
  1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
  2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.
- D. LED Lighting - Control Compatibility Submittal:
  1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.
- E. Submit Design Lights Consortium (DLC) information for each luminaire type.
- F. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

#### **1.5 EXTRA STOCK**

- A. Provide extra stock under provisions of Section 260500.

- B. LED Light Engines or Modules: Ten (10) percent of quantity installed, minimum one (1) of each size and type of field replaceable light engine or module. Provide field replacement installation instructions.
- C. Lenses: Three (3) percent of quantity installed, minimum one (1) of each size and type.
- D. LED Drivers: Ten (10) percent of quantity installed, minimum one (1) of each size and type.
- E. Exit Signs: Provide three (3) additional exit sign luminaires complete with labor, conduit, and wire. Additional exit luminaires shall be located per the Architect/Engineer or provided as attic stock when a location is not defined prior to Owner occupancy. When multiple exit signs are scheduled, the quantity listed above shall represent each type listed.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site. Store and protect under provisions of Section 260500.
- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- C. Handle site lighting poles carefully to prevent breakage and damage to finish.

#### **1.7 MOCKUP**

- A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Approved luminaires in mockup may be reused as part of complete work if in original condition.

#### **1.8 WARRANTY**

- A. The warranty period begins at the date of Substantial Completion.
- B. LED Light Engines and Drivers:
  - 1. LED Drivers and Dimming Drivers: Five (5) years
  - 2. Light Emitting Diode (LED) Light Engines: Five (5) years
- C. Emergency Lighting Units and Exit Signs:
  - 1. Emergency Lighting Units: Three (3) year, non-prorated
  - 2. Exit Signs: Three (3) year, non-prorated
  - 3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.
- D. Emergency Drivers:
  - 1. Emergency LED Driver: Five (5) years
- E. Emergency Inverter for LED Light Engines:
  - 1. Emergency Inverter and Battery: Sealed nickel cadmium five (5) year, non-prorated.
- F. Automatic Load Control Relay (ALCR): Five (5) year
- G. Pole Finish: Three (3) year warranty of pole color and finish

## 1.9 REGULATORY REQUIREMENTS

- A. Conform to NFPA 101 for installation requirements

## PART 2 - PRODUCTS

### 2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.
- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.
- D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.
- E. Painted reflector surfaces shall have a minimum reflectance of 90%.
- F. All painted components shall be painted after fabrication.

### 2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.
- B. Provide low temperature LED drivers, with reliable starting to -20°F.
- C. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115°F. Compartment separation of wire entry and control gear/lamp chamber.
- D. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

### 2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. The R9 color rendering value shall be a minimum of 50. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.
- B. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

- C. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- D. Rated life shall be minimum of 50,000 hours at L70.
- E. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- F. Dynamic Tunable LED (DLED): Variable correlated color temperature LED systems shall offer a range of temperature control from 3000K through 5000K. Color rendering index shall be a minimum of 80. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.
- G. Warm Dim LED (WLED): Variable warm dimming LED systems shall offer a range of temperature control from 3000K through 1800K. Color rendering index shall be a minimum of 80. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.
- H. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.
- I. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.
- J. LED light engine shall have a maximum LLD of 0.85 at 100,000 hours at 25°C ambient.
- K. LED Driver:
  - 1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
  - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
  - 3. Driver shall have a minimum of 50,000 hours rated life.
  - 4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
  - 5. Driver shall be field replaceable without removal of the luminaire.
  - 6. Class A sound rating; inaudible in a 27 dBA ambient.
  - 7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

## **2.4 LED EMERGENCY LIGHTING UNITS**

- A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.

- C. Charger: Dual-rate solid state current charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.
- D. LED Lamp Wattage: As scheduled on luminaire schedule.
- E. Remote Lamps: Match LED lamps on unit.
- F. Indicators: Provide lamps to indicate AC ON and RECHARGING. Provide voltmeter.
- G. Provide test switch to transfer unit from normal supply to battery supply.
- H. Electrical Connection: Knockout for conduit connection.
- I. Unit Voltage: Refer to luminaire schedule volts, AC.
- J. Self-Diagnostics and Testing:
  1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
  2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

## 2.5 EMERGENCY EXIT SIGNS

- A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.
- B. Self-Powered Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings. One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, test switch, AC ON pilot light, automatic charger, and electronic circuitry. Power failure relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- C. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.
- D. Self-Diagnostics and Testing:
  1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
  2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five minute discharge/diagnostic test at any time.

## 2.6 EMERGENCY INVERTER FOR LED LIGHT ENGINES (INDIVIDUAL LUMINAIRES - INTEGRAL)

- A. Unit: Self-contained, with automatic transfer to battery supply on loss of normal power, UL 924 listed for factory or field installation, indoor and damp locations, 32°F to 122°F operating temperature. Compatible with switched, dimmed, and unswitched lighting controls. Compatible with LED light engines. The inverter output shall be sinusoidal with solid-state low voltage disconnect circuit.
- B. Battery: Sealed, high temperature, maintenance free, nickel cadmium battery with capacity to provide 90 minutes of emergency operation at full lumen and wattage output, with 24-hour recharge time. Refer to Luminaire Schedule for lumen and wattage requirements.
- C. Features: Integral battery charger with LED charging indicator light, test switch, electronic circuitry for use with LED drivers. Test and monitor switch shall be integral to luminaire or mounted flush in finished ceiling per Luminaire Schedule.
- D. Factory and Field Installation: Listed for installation inside and adjacent to luminaire. Refer to Luminaire Schedule for individual luminaire requirements. Remote-mounted units shall be located above finished ceiling, adjacent to luminaire, and accessible from below through luminaire opening.
- E. Self-Test Diagnostics and Testing: Provide with listed automatic monthly self-test diagnostics.
- F. Manufacturers:
  - 1. Myers LVU Series

## 2.7 LIGHTING POLES

- A. Manufacturers:
  - 1. Manufacturer of luminaire (metallic pole)
  - 2. Valmont Poles (metallic pole)
  - 3. U.S. Pole Company (metallic pole)
  - 4. KW Industries (metallic pole)
  - 5. Ameron Pole Products Division (concrete pole)
  - 6. Stresscrete (concrete pole)
  - 7. Traditional Concrete (concrete pole)
  - 8. TimberWood (wooden pole)
  - 9. Lithonia (wooden pole)
  - 10. Valmont NV (wooden pole)
- B. Metal Poles: Square steel lighting pole with anchor base.
  - 1. Painted steel poles shall have electrostatic applied polyester powder coated paint finish thermally cured with UV protection. Interior of pole shall be coated with same coating for a minimum of 12" from base plate.
  - 2. Galvanized steel hot dipped finish to standard AASHTO M 111.
  - 3. Anodized aluminum finish to MIL-A-8625 Type II, minimum 0.8 mil thickness. Provide anodized color sample to Architect/Engineer prior to ordering.

- C. Fiberglass Direct Embedded Pole: Fiberglass reinforced composite shaft constructed by filament winding "E" type fiberglass with thermosetting polyester resin. The resin shall be pigmented, UV inhibiting with a polyurethane top coating. Pole shall have a handhole 18" above grade and a wiring access opening 24" below grade.
- D. Laminated Wood Poles: Raceway type lighting pole; pressure treat with alkaline copper quaternary (ACQ) preservative. Wood species and finish selection by Architect/Engineer.
- E. Wind Load: 100 MPH velocity, with 1.14 percent three-second gust factor with luminaires and brackets mounted.
- F. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.
- G. Pole Top: Provide mast arm(s) in array as indicated.
- H. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.
- I. Vibration Damper: Canister or snake type second mode vibration damper internal to the metal pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head metal poles where recommended by manufacturer.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.
  - 1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:
    - a. Luminaires less than 56 lbs: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.
    - b. Luminaires 56 lbs or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.
    - c. Luminaires larger than eight square feet (8 ft<sup>2</sup>): Support luminaire independent of the ceiling system.
- B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.



- C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.
- E. Provide seismic bracing of luminaires per IBC Chapter 16. Design pendant luminaires on a component seismic coefficient (Cc) of 0.67. Design vertical supports with a factor of safety of 4.0. Contractor shall verify the Seismic Hazard Exposure Group and Performance Criteria Factor.
- F. Install lamps in lamp holders of luminaires.
- G. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.
- H. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- I. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.
- J. Embedded Luminaire Poles: Depth as indicated. Install plumb.
- K. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

### **3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES**

- A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.
- B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

### **3.3 AUTOMATIC LOAD CONTROL RELAYS**

- A. Factory or field installation per manufacturer requirements.
- B. Remote Test Switch: Provide connection to remote test switch.
- C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

### **3.4 EMERGENCY LIGHTING UNITS AND EXIT SIGNS**

- A. Install units plumb and level.
- B. Aim directional lamp heads as directed.
- C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

**3.5 RELAMPING**

- A. Replace failed LED light engine modules or arrays at completion of work.

**3.6 ADJUSTING AND CLEANING**

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

**3.7 OWNER TRAINING**

- A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.
- B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

**3.8 LUMINAIRE SCHEDULE**

- A. As shown on the drawings.

END OF SECTION 265119

**SECTION 270500 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

**1.2 SCOPE OF WORK**

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Communications Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Communications Work a finished and working system.
- C. Description of Systems include, but are not limited to, the following:
  - 1. Complete Structured Cabling System including, but not limited to:
    - a. Voice and data backbone cabling and terminations.
    - b. Voice and data horizontal cabling and terminations.
    - c. Information outlets (IOs) including faceplates, jacks and labeling.
    - d. Equipment racks, cabinets, cable management and equipment.
    - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
    - f. Cabling pathways.
    - g. Grounding and Bonding
    - h. Testing
  - 2. Mounting and patching of wireless access points provided by others.
  - 3. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
  - 4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
  - 5. Firestopping of penetrations as described in Section 270503.

**1.3 OWNER FURNISHED PRODUCTS**

- A. Wireless Access points
- B. Network router
- C. Network switches
- D. Select Racks and Cabinets

**1.4 ALTERNATES**

- A. Not applicable

**1.5 UNIT PRICES**

- A. Not applicable

**1.6 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS**

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
  2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
  3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
  4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
  5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling.
- C. General:
1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, conduit, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.
  2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.
  3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.

4. Where the Electrical Contractor is required to install cable tray that will contain low voltage technology wiring, the installation shall not begin until the Technology Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity Flow Piping, including Steam and Condensate
  - c. Sheet Metal
  - d. Electrical Busduct
  - e. Cable Trays, including 12" access space
  - f. Sprinkler Piping and other Piping
  - g. Conduit and Wireway
  - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Communications Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.7 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

- a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
  3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
  2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

- a. Scale of drawings:
  - 1) General plans: 1/4 Inch = 1'-0" (minimum).
  - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
  - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
  - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
  - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.8 QUALITY ASSURANCE

### A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
  - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
  - b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
    - 1) C.1 - Commercial Building Telecommunications Standard
    - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
    - 3) C.3 - Optical Fiber Cabling Components Standard
  - c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
  - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
  - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
  - g. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - h. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
  - i. NFPA 70 (NEC) - National Electrical Code (Current Edition)
  - j. UL 444 - Standard for Safety for Communications Cable

### B. Refer to individual sections for additional Quality Assurance requirements.

### C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.



6. The Contractor shall have certified BICSI installation technicians or CNet CNIT (Certified Network Infrastructure Technician) on staff to perform the following tasks on the project:
  - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
  - b. Oversee all testing and termination of cabling.
7. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
  - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
  - b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
  - c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
  - d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
  - e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
  - f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of the Missouri Highway Patrol.
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
6. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
7. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
  - a. Factory Mutual
  - b. Underwriters' Laboratories, Inc.

F. Service Provider Requirements:

1. Secure from the telecommunications service provider all applicable requirements.
2. Comply with all service provider requirements.
3. The Owner shall make application for and pay for new telecommunications service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and service provider.

G. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

I. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

## 1.9 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawings
27 05 03	Through Penetration Firestopping	
27 05 26	Communications Bonding	
27 05 28	Interior Communications Pathways	Yes
27 05 43	Exterior Communications Pathways	Yes
27 05 53	Identification and Administration	
27 11 00	Communication Equipment Rooms	Yes
27 13 00	Backbone Cabling Requirements	
27 15 00	Horizontal Cabling Requirements	
27 17 10	Testing	

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Description of items submitted and relevant specification number
  - e. Notations of deviations from the contract documents
  - f. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Description of item submitted (using project nomenclature) and relevant specification number
  - g. Notations of deviations from the contract documents
  - h. Other pertinent data
  - i. Provide space for Contractor's review stamps
  
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
  
5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.
  - d. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

- e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - f. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
- a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

- 1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
- 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
- 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 27 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 27 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

#### **1.10 SCHEDULE OF VALUES**

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.
- C. Preparation:
  1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
  2. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  3. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.
  4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Structured cabling
- D. Update Schedule of Values when:
  1. Indicated by Architect/Engineer.
  2. Change of Subcontractor or supplier occurs.
  3. Change of product or equipment occurs.

**1.11 CHANGE ORDERS**

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

**1.12 EQUIPMENT SUPPLIERS' INSPECTION**

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
  - 1. Firestopping, including mechanical firestop systems.

**1.13 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE**

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

**1.14 NETWORK / INTERNET CONNECTED EQUIPMENT**

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

**1.15 WARRANTY**

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

#### **1.16 INSURANCE**

- A. Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

#### **1.17 MATERIAL SUBSTITUTION**

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

### **PART 2 - PRODUCTS**

#### **2.1 CABLE JACKET RATING**

- A. This project requires all cable jackets to carry a plenum rating.



**2.2 Refer to individual sections.****PART 3 - EXECUTION****3.1 JOBSITE SAFETY**

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

**3.2 GENERAL INSTALLATION REQUIREMENTS**

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 260533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

**3.3 FIELD QUALITY CONTROL**

- A. General:
  - 1. Refer to specific Division 27 sections for further requirements.
  - 2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
  - 3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.

4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

### 3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
  2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
  3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
  1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
  2. Submitted bound copies of approved shop drawings.
  3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
  4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
  5. Submitted testing reports for all systems requiring final testing as described herein.

6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.
8. Provide System Assurance Warranty certificate for the telecommunications system.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div27.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

#### C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### **3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE**

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- D. Refer to the individual specification sections for minimum hours of instruction time for each system.
- E. Operating Instructions:
  1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
  2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### **3.7 SYSTEM STARTING AND ADJUSTING**

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### **3.8 RECORD DOCUMENTS**

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.
- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

### **3.9 ADJUST AND CLEAN**

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

- 1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
- 2. All mechanical firestop products are installed and all other penetrations have been sealed.
- 3. All telecommunications jacks are installed in the faceplates.
- 4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
- 5. Telecommunications testing is in progress and at least 25% of testing has been completed.
- 6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
- 7. All telecommunications related grounding is complete.
- 8. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: \_\_\_\_\_ By: \_\_\_\_\_

Requested Observation Date \_\_\_\_\_ Today's Date: \_\_\_\_\_

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

TELECOMMUNICATIONS - PROOF OF CERTIFICATION

There are specific Contractor qualification requirements for this project as defined in Section 270500, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer <Insert>. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: \_\_\_\_\_

Authorized Representative: (print) \_\_\_\_\_

Date: \_\_\_\_\_

Manufacturer Certification Number (if any): \_\_\_\_\_

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: \_\_\_\_\_

RCDD #: \_\_\_\_\_ Expiration: \_\_\_\_\_

Submit the following with the bid:

This form.

Proof of Manufacturer Certification indicated above.

Proof of RCDD or CNIDP status.

END OF SECTION 270500

**SECTION 270503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. The Building Officials and Code Administrators National Building Code
- J. International Building Code
- K. NFPA 5000 – Building Construction Safety Code

**1.4 SUBMITTALS**

- A. Submit under provisions of Section 270500.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.



2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  4. F ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

## 1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  2. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. at both ambient temperature and 400°F.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  - 1. Review foreseeable methods related to firestopping work.
  - 2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  - 1. Specified Technologies Inc. (S.T.I.) EZ Path 44+

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

## 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

- a. F Rating = Floor/Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

## 2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

## 3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall/Floor Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### **3.2 INSTALLATION**

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

#### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

**3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

**3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION 270503

**SECTION 270526 - COMMUNICATIONS BONDING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Bonding Conductors
- B. Bonding Connectors
- C. Grounding Busbar (TMGB and TGB)
- D. Rack-mount Telecommunications Grounding Busbar

**1.2 RELATED WORK**

- A. Section 260533 - Conduit and Boxes
- B. Section 260513 - Wire and Cable
- C. Section 260526 - Grounding and Bonding
- D. Section 270500 - Basic Communications Systems Requirements
- E. Section 270503 - Through Penetration Firestopping
- F. Section 271100 - Communication Equipment Rooms
- G. Section 270528 - Interior Communication Pathways
- H. Section 270553 - Identification and Administration

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for relevant standards.
- B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.
- C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

**1.4 REFERENCES**

- A. ANSI/IEEE 1100 - Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C - Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces

- D. ANSI/TIA/EIA 606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 - Customer Owned Outside Plant
- F. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- G. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- H. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- I. NFPA 70 - National Electrical Code
- J. NFPA 780 - Standard for the Installation of Lightning Protection Systems
- K. UL 96 - Lightning Protection Components
- L. UL 96A - Installation Requirements for Lightning Protection Systems
- M. UL 467 - Grounding and Bonding Equipment

### **1.5 SUBMITTALS**

- A. Submit product data and shop drawings under provisions of Section 270500 and Division 1.
- B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
  - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.
  - 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Provide CAD-generated, project-specific system shop drawings as follows:
  - 1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.
  - 2. Installation details for all system components.
- D. Provide system checkout test procedure to be performed at acceptance.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to the site under the provisions of Section 270500.

- B. Store and protect products under the provisions of Section 270500.
- C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

### **1.7 SYSTEM DESCRIPTION**

- A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.
- B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.
- D. Basic System Requirements:
  - 1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
  - 2. The bonding system shall include, but not be limited to, the following major components:
    - a. Bonding Conductor for Telecommunications (BCT)
    - b. Telecommunications Main Grounding Busbar (TMGB)
    - c. Telecommunications Bonding Backbone (TBB)
    - d. Telecommunications Grounding Busbar(s) (TGB)
    - e. Rack mount Telecommunications Grounding Busbar(s)
    - f. Bonding Conductor(s) (BC)
    - g. Bonding Connectors
    - h. Bonding system labeling and administration as defined in Section 270553.

### **1.8 PROJECT RECORD DOCUMENTS**

- A. Submit documents under the provisions of Section 270500.
- B. Provide final system block diagram showing any deviations from approved shop drawing submittal.
- C. Provide floor plans that document the following:
  - 1. Actual locations of system components, devices, and equipment.
  - 2. Actual conductor routing.
  - 3. Actual system component, device, equipment, and conductor labels.



- D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.
- E. Complete all operation and maintenance manuals as described below.

### **1.9 OPERATION AND MAINTENANCE DATA**

- A. Submit under provisions of Section 270500.
- B. Submitted data shall include:
  - 1. Approved shop drawings.
  - 2. Descriptions of recommended system maintenance procedures, including:
    - a. Inspection
    - b. Periodic preventive maintenance
    - c. Fault diagnosis
    - d. Repair or replacement of defective components

## **PART 2 - PRODUCTS**

### **2.1 BONDING CONDUCTORS**

- A. Bare Copper:
  - 1. Annealed uncoated stranded conductor.
  - 2. Minimum size 6 AWG.
- B. Insulated Copper:
  - 1. Annealed uncoated stranded conductor.
  - 2. Insulation:
    - a. PVC insulation with nylon outer jacket.
    - b. Rated at 600 volts.
    - c. Green.
  - 3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.
- D. Bonding Conductor Sizing:
  - 1. All communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

## 2.2 BONDING CONNECTORS

- A. Acceptable Types:
  1. Two-hole compression lug
  2. Exothermic weld
  3. Irreversible compression
- B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.
- C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

## 2.3 GROUNDING BUSBAR (TMGB AND TGB)

- A. Features:
  1. Wall-mount configuration.
  2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
  3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
  4. Predrilled holes.
  5. Integral insulators.
  6. Stainless steel offset mounting brackets.
- B. Specifications:
  1. Material: Electrolytic tough pitch copper bar with tin plating.
  2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
    - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
  3. Hole pattern shall include:
    - a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.
    - b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

## 2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

### A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
2. Predrilled holes.
3. Mounts in a standard 19" equipment rack.

### B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
  - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
  - a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
  - b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

#### B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.
2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.
3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.
4. In service entrance rooms where the entrance pathway contains an isolation gap, the pathway on the facility side of the gap shall be bonded to the TMGB.

#### C. Where the service entrance cable contains a shield, the shield(s) shall be bonded to the TMGB using manufacturer-approved hardware.

#### D. Telecommunications Main Ground Bar (TMGB) Requirements:

1. Install TMGB such that it is insulated from its support with a minimum 2" standoff.

2. Bond the TMGB to the electrical service ground via the BCT.
  - a. A minimum of 1 foot separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.
3. Where backbone or horizontal cabling contains a shield, the shield(s) shall be bonded to the TMGB.
4. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.
5. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.
6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.
7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.

E. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.
2. Install TGB such that it is insulated from its support with a minimum 2" standoff.
3. Bond each TGB to the TMGB via the TBB.
  - a. A minimum of 1 foot separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
  - b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.
4. When there are multiple telecommunications equipment rooms on each floor in buildings containing more than five stories, the TGBs on the same floor shall be bonded together horizontally using a grounding equalizer (GE) on the first, last, and every third intermediate floor. GE conductors shall be the same size as the TBB.
5. If more than one (1) TGB is provided within the same room or space, they shall all be bonded together via a BC the same size as the TBB.
6. Where horizontal cabling contains a shield, the shield(s) shall be bonded to the TGB.
7. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.
8. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.
9. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
10. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.

F. Rack-mount Telecommunications Ground Bar Requirements (RTGB):

1. Provide a rack-mount telecommunications ground bar in each equipment rack and equipment rack enclosure.

2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.
3. Bond each RTGB to the TGB via a BC.
4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.
5. Where horizontal cabling containing a shield is terminated on rack-mounted termination hardware, the shield(s) shall be bonded to the RTGB.
6. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.

G. Metallic Interior Communication Pathway Bonding Requirements:

1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.

H. Bonding Conductor Requirements:

1. Bonding conductors shall be green or marked with a distinctive green color.
2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.
3. Bonding conductors shall not be installed in metallic conduit.
4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.
  - a. Where documented permission to splice a conductor is granted:
    - 1) The number of splices shall be limited to as few as possible.
    - 2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.
    - 3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
    - 4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
5. All bonding conductors shall be labeled in accordance with the requirements of Section 270553. In addition to the requirements of Section 270553:
  - a. Labels shall be nonmetallic.
  - b. Labels shall be printer-generated.
  - c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.

d. Additionally, conductors shall be labeled as follows:

1) "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."

6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

I. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.
2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
3. Thoroughly clean conductors before installing lugs and connectors.
4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.
5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.
7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

### 3.2 FIELD QUALITY CONTROL

- A. Field testing shall be performed under provisions of Section 270500.
- B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.
- C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

### 3.3 ADJUSTING

- A. Adjust work under provisions of Section 270500.
- B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

### 3.4 TESTING

- A. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.
  - 1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
  - 2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.
  - 3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.
- B. Measure and document voltage between screen of installed and terminated ScTP, FTP, and/or SSTP horizontal cables and electrical ground of electrical outlet(s) serving the information outlet location area.
  - 1. The voltage between the screen and the ground wire shall not exceed 1.0 V rms, and 1.0 V dc for any installed and terminated ScTP, FTP, and/or SSTP horizontal cables.

### 3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
  - 1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
  - 2. The Architect/Engineer shall be presented with the option to attend the training.
  - 3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
  - 1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.
- C. Minimum on-site training times shall be:
  - 1. Technical user: One hour.

END OF SECTION 270526

**SECTION 270528 - INTERIOR COMMUNICATION PATHWAYS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete wire mesh support systems, conduits, sleeves, innerduct, etc. for an interior cabling plant as shown on the drawings.

**1.2 RELATED WORK**

- A. Section 260533 - Conduit and Boxes
- B. Section 270500 - Basic Communications Systems Requirements
- C. Section 270526 - Communications Bonding

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for requirements.

**1.4 REFERENCES**

- A. ANSI/NFPA 70 - National Electrical Code

**1.5 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
  - 1. Include conduit sleeve layout in composite electronic coordination files. Refer to Section 270500 for coordination drawing requirements.

**1.6 DRAWINGS**

- A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.



## **PART 2 - PRODUCTS**

### **2.1 CONDUIT**

- A. Refer to Section 26 05 33 for conduit requirements for this project.

### **2.2 CABLE HANGERS AND SUPPORTS**

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
  1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
  2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
  3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.
- C. Cable Hangers:
  1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
  2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
  3. Slings shall be adjustable to a capacity of 425 4-pair UTP cables.
  4. Cabling hanger load limit shall be 100 lbs per foot.
  5. Manufacturer:
    - a. Erico Caddy
    - b. CableCat CAT425
    - c. Arlington Fittings TI Series
    - d. Or approved equal.

### **2.3 INNERDUCT - CORRUGATED**

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.
- B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.
- C. Solvent-cement type joints as recommended by manufacturer.
- D. Inside diameter not less than that of rigid steel conduit.
- E. Dielectric strength a minimum of 400 volts per mil.
- F. Corrugated wall construction.
- G. Pull rope pre-installed by manufacturer.
- H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all the above General requirements plus:
  1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.

2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).
- I. Innerduct installed within building riser shafts shall meet all the above general requirements plus:
  1. Be fabricated of flame-retardant materials suitable for installation in such environment.
- J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

### **PART 3 - EXECUTION**

#### **3.1 INNER DUCT INSTALLATION REQUIREMENTS**

- A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.
- B. All exposed inner duct is to be labeled at 35-foot intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).
- C. Where exposed, fiber optic cable shall be installed in protective inner duct.
- D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.
- E. The inner duct should extend into the termination enclosure at system endpoints.
- F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

#### **3.2 CABLE HOOK SUPPORT SYSTEM**

- A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- E. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet.

- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.
- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

### **3.3 CONDUIT AND CABLE ROUTING**

- A. Refer to Section 260533 for additional requirements.
- B. All conduits shall be reamed and shall be installed with a nylon bushing.
- C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
- D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.
- E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
  - 1. A separate pull box is required for each 90' (or greater) length section.
  - 2. A separate pull box is required after any two (2) consecutive 90-degree bends.
  - 3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.
- F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.
- G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

### **3.4 ATTACHMENT TO METAL DECKING**

- A. Where supports for cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION 270528

**SECTION 270543 - EXTERIOR COMMUNICATION PATHWAYS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes the products and execution requirements relating to furnishing and installing exterior racks, ladders, conduits, sleeves, innerduct, etc. for an exterior cabling plant.

**1.2 REFERENCES**

- A. Section 270500 - Basic Communications Systems Requirements.
- B. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- D. ASTM A48 - Gray Iron Castings.
- E. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

**1.3 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Submit shop drawings and product data under provisions of Section 270500.
- C. Submit manufacturer's installation instructions under provisions of Section 270500.
- D. Coordination Drawings:
  - 1. Include manholes, hand holes, and conduits 1.5" and larger in coordination files. Include all in-floor and underfloor conduit in coordination files. Refer to Section 270500 for coordination drawing requirements.

**1.4 REGULATORY REQUIREMENTS**

- A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

**PART 2 - PRODUCTS****2.1 OUTSIDE PLANT CONDUIT**

- A. Rigid Metallic Conduit (RMC) and Fittings:

1. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
  2. Fittings and Conduit Bodies:
    - a. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
    - b. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
    - c. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
    - d. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
    - e. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
  3. Manufacturers:
    - a. Allied
    - b. LTV
    - c. Steelduct
    - d. Wheatland Tube Co
    - e. O-Z Gedney
    - f. Or pre-approved equal
- B. Rigid Non-Metallic Conduit (RNC) and Fittings:
1. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.
  2. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
  3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.
  4. Manufacturers:
    - a. Carlon (Lamson & Sessions) Type 40
    - b. Cantex
    - c. J.M. Mfg.
    - d. or pre-approved equal
- C. High-Density Polyethylene (HDPE) Conduit:
1. Minimum Size: 2 inches, unless noted otherwise.
  2. Acceptable Manufacturers:
    - a. Carlon
    - b. Chevron Phillips Chemical Company
    - c. or pre-approved equal.
  3. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	Less than 0.941
D-1238	Melt Index, g/10 min Condition E	Greater than 0.55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	Less than 80,000
D-746	Brittleness Temperature	-75°C Max

4. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
5. Fitting and Conduit Bodies:
  - a. Directional Bore and Plow Type Installation: Electrofusion or universal aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
  - b. For All Other Types of Installation: Coupler must provide a watertight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
  - c. E-loc type couplings are not acceptable in any situations.
  - d. Acceptable Manufacturers:
    - 1) ARCON
    - 2) Carlon
    - 3) or approved equal.

D. Fittings:

1. Sweeps: Factory manufactured RMC wrapped with 4 mil vinyl tape with a bend radius as follows:
  - a. Conduit internal diameter of 2" or less is 6 times the internal conduit diameter.
  - b. Conduit internal diameter of more than 2" is 10 times the internal conduit diameter.
2. End Caps (Plugs): Pre-manufactured and watertight. Tape is not an acceptable end cap or cover.

## 2.2 HAND-HOLES

A. Dimensions:

1. As indicated on the drawings.

B. Requirements:

1. Includes polymer concrete cover.

C. Acceptable Manufacturers

1. Quazite

- 2. Old Castle Precast Christy®®
- 3. New Basis.

**2.3 TEXTILE INNERDUCT**

- A. Contractor shall provide and install innerduct in each conduit identified to have copper and fiber optic cable installed.
- B. Innerduct shall have an 18 gauge solid copper core tracer wire installed into each cell to allow for detection by industry standard toning equipment.
- C. Each innerduct cell shall have a pull tape installed.
- D. Acceptable Manufacturers:
  - 1. Maxcell
  - 2. or pre-approved equal.

SIZE	OD	ID
1"	1.375" (Max.)	1.0" (Min.)
1-1/4"	1.67" (Max.)	1.25" (Min.)
1-1/2"	2.0" (Max.)	1.5" (Min.)

**2.4 UNDERGROUND WARNING TAPE**

- A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
- B. Overall Thickness: 5 mils.
- C. Foil Core Thickness: 0.35 mil.
- D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with "CAUTION "" BURIED COMMUNICATIONS LINE BELOW". Printing on tape shall be permanent and shall not be damaged by burial operations.
- E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- F. Comply with ANSI Z535.1 through ANSI Z535.5.

**PART 3 - EXECUTION**

**3.1 INSTALLATION - HAND-HOLES**

- A. Install gravel drainage bed a minimum of 6" depth below hand-hole using a minimum gravel size of 1 inch.
- B. Provide units and/or extensions as required by conduit depth for hand-hole cover to be flush with finished grade.
- C. Slope grade away from cover with a slope of approximately 1 inch in 3 feet.

### 3.2 INSTALLATION - TEXTILE INNERDUCT

- A. Provide two (2) 3-cell innerducts per 4" conduit or as recommended by the manufacturer.
- B. Install innerduct per manufacturer's guidelines.
- C. Cut and tie off innerduct and pull tape inside each communications vault or Entrance Room.

### 3.3 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
  - 1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.
- B. Excavation:
  - 1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.
  - 2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.
  - 3. Excavations shall be protected against frost action and freezing.
  - 4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.
  - 5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.
  - 6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
  - 7. Where satisfactory bearing soil is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately and no further work shall be done until further instructions are given.
  - 8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.
- C. Dewatering:
  - 1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.
- D. Underground Obstructions:
  - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.



E. Fill and Backfilling:

1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.
2. The Contractor shall provide the necessary sand for backfilling.
3. Dispose of the excess excavated earth as directed.
4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.
5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.
6. All conduit shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.
7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. Native soil materials may be used as backfill if approved by the Geotechnical Engineer. All other conduit shall have sand backfill to 6" above the top of the conduit.
8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.
9. Install a warning tape approximately 12 inches below finished grade over all underground duct banks. The identifying warning tape shall be as specified above.
10. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

### 3.4 RESTORATION REQUIREMENTS

- A. Where soil and sod has been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching,

END OF SECTION 270543

**SECTION 270553 - IDENTIFICATION AND ADMINISTRATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes the identification and administration requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Identification and labeling.

**1.2 RELATED WORK**

- A. Section 270500 - Basic Communications Systems Requirements

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for relevant standards.
- B. Perform all work in accordance with the Missouri Highway Patrol standard.

**1.4 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:

**PART 2 - PRODUCTS****2.1 LABELING**

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
  - 1. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.
- E. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
  - 1. (Room Number) - (Outlet Number) - (Jack Number) - (Use).
  - 2. "Outlet Number" shall start with 1 in each room, with additional outlets in each room numbered sequentially.

3. "Jack Number" shall start with 1 for the upper left jack in each outlet, increasing sequentially from left to right and top to bottom across the outlet face.
- F. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:
1. (Telecom Room Number) - (Patch Panel Letter) - (Patch Panel Port Number).
  2. "Telecom Room Number" shall be as indicated on the drawings.
  3. "Patch Panel Letter" shall start with 'A' for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.

## 2.2 DOCUMENTATION/AS-BUILTS/RECORDS

- A. General:
1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 270500 and Division 1. Documentation shall include the items detailed in the subsections below.
  2. All documentation, including hard copy and electronic forms shall become the property of the Owner.
- B. Record Drawings:
1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

## PART 3 - EXECUTION

### 3.1 IDENTIFICATION AND LABELING

- A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.
1. Provide additional cable labeling at each manhole and pull box.
  2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
  3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.
- B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.
- C. Termination Hardware Labeling:
1. An identifier shall be provided at each termination hardware location or its label.

D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.
2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

END OF SECTION 270553

**SECTION 271100 - COMMUNICATION EQUIPMENT ROOMS (CER)****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

**1.2 RELATED WORK**

- A. Section 270500 - Basic Communications Systems Requirements
- B. Section 270526 - Communications Bonding
- C. Section 270528 - Interior Communication Pathways
- D. Section 271500 - Horizontal Cabling Requirements

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for applicable standards.

**1.4 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
  - 1. Include equipment racks, conduit sleeve layout in composite electronic coordination files. Refer to Section 270500 for coordination drawing requirements.

**PART 2 - PRODUCTS****2.1 EQUIPMENT GROUNDING**

- A. Refer to specification section 270526 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

**2.2 EQUIPMENT RACKS AND CABINETS**

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Wall Cabinet:
  - a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 15 RU. Racks shall be a minimum of 21 inches deep. Access to the rear of the cabinet-mounted equipment shall be by a hinged arrangement.
  - b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.
  - c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. The cabinet shall be tapped to accept 12-24 screws.
  - d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

### **2.3 CABLE MANAGEMENT - VERTICAL AND HORIZONTAL**

A. Equipment Cabinets

1. Equipment cabinets shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, to allow an orderly routing of optical fiber and copper jumpers from the modular patch panel and/or 110-type termination blocks to the customer provided network electronics. At a minimum, one such horizontal cable management panel shall be provided with each equipment cabinet. Horizontal cable management panels shall be 3.5" in height and have a minimum of five (5) jumper distribution rings.

### **2.4 PATCH PANELS**

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 271500. On wall-mounted panels, this interface shall be accessible from the front of the panel.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.
- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

## 2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.
- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.
- D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or  $\frac{1}{2}1\frac{1}{2}$ ", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where "Loose Buffered" cables are installed, the 250  $\mu\text{m}$  coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar $\phi\phi$ ) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250  $\mu\text{m}$  coated optical fibers shall not be permitted.
- H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

## 2.6 OPTICAL FIBER COUPLERS/ADAPTERS

- A. Optical Fiber Couplings (LCtype) (Multimode/Singlemode):

1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
2. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
6. LC-type optical fiber couplings shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Performance Requirements:
  - a. Length: 2 inches
  - b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
  - a. Hubbell

## 2.7 D-RINGS

- A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.
- B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.
- C. Provide 1/4" screw holes for wall mounting.

## 2.8 COPPER PATCH CORDS

- A. Modular Patch Panel:
  1. Provide Category 6 Enhanced copper patch cords for all assigned ports on the modular patch panel. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
  2. Refer to Section 271500 for cable and connector performance requirements.
  3. Patch cords shall not be made-up in the field.
  4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
    - a. Hubbell HC Series

## 2.9 FIBER PATCH CORDS

- A. Optical Fiber Patch Cords (Multimode):



1. Provide 50/125 mm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
2. Channels shall be of equal length.
3. Refer to Section 271500 for cable and connector performance requirements.
4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

a. Hubbell DFPC Series

B. Optical Fiber Patch Cords (Singlemode):

1. The optical fiber patch cord shall be 8.3/3 mm singlemode (SM) optical fiber, utilizing tight buffer construction. The optical fiber patch cords shall be a minimum of 5 feet in length.
2. Provide 8.3/3 mm singlemode (SM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
3. Channels shall be of equal length.
4. Refer to Section 271500 for cable and connector performance requirements.
5. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

a. Hubbell DFPC Series

## 2.10 LIGHTNING PROTECTION

- A. Contractor shall provide multipair protector panel(s), including mounting and termination hardware. The multipair protector panel(s) shall be UL listed.
- B. For small pair count applications (less than or equal to 200-pairs), the multipair protector panel shall consist of a mounting panel for a series of solid-state protector units, 710-type connector for input, and 110-type termination blocks for output. Insertion of the protector units into the mounting panel will complete the circuit. The multipair protector panel(s) shall be available in 25-, 50-, 100-, and 200-pair counts.
- C. For large pair count applications (greater than 200 pairs) or when the multipair protector panel is separated from the cross-connect field, the multipair protector panel shall consist of a metal housing containing mountings for a series of solid-state protector units. The protector units shall include a 25-foot, 26 AWG stub cable that serves as a fusible link, a 24 AWG terminating cable, and two connectors for external ground connections. The protection devices shall be available in 50- and 100-pair counts.
- D. Solid State Protection Units:
  1. DC Breakdown Voltage (at 2 kV/sec): 220-300V.
  2. Surger Breakdown Voltage (at 100 V/μsec): 220-300V.
  3. Insulation Resistance: >100 M W typical.
  4. DC Holdover Current: 260 mA/52V, 200 mA/135V, 140 mA/150V.
  5. Capacitance: Less than 100 pF.

6. Rated Impulse Discharge: 200A.
7. On-state Voltage (at 100A): Less than 10V.
8. Response Time: Less than 100 nsec.
9. Line Series Resistance: Less than 4 W
10. Sneak Current Operation (heat coils): 540 mA = Less than 210 sec; 1A = Less than 15 sec

## **2.11 DEMARCATION REQUIREMENTS**

- A. Contractor shall coordinate all requirements for the demarcation point with the Owner's selected service provider.
- B. The Contractor shall not proceed with any installation without written communication with the Architect/Engineer should the service provider's requirements differ from the work shown on the contract documents.
- C. Refer to the drawings for further requirements.

## **PART 3 - EXECUTION**

### **3.1 EQUIPMENT RACKS**

- A. Equipment racks shall be furnished and installed as shown on the drawings.

### **3.2 D-RINGS**

- A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
- B. Locate D-rings on 24" centers vertically and horizontally.
- C. Securely attach D-rings to the wall as required by the manufacturer.

### **3.3 GROUNDING**

- A. Provide a complete grounding system in accordance with the requirements of Section 270526.

### **3.4 CROSS CONNECT INSTALLATION**

- A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.
- B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
- C. The cable jacket shall be maintained as close as possible to the termination point.
- D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

**3.5 OPTICAL FIBER TERMINATION**

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.
- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

**3.6 CONDUITS AND CABLE ROUTING**

- A. Refer to Section 260533 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.
- C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with a nylon bushing.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION 271100

**SECTION 271300 - BACKBONE CABLING REQUIREMENTS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

**1.2 RELATED WORK**

- A. Section 270500 - Basic Technology Systems Requirements.
- B. Section 271500 - Horizontal Cabling Requirements.
- C. Section 271720 - Structured Cabling System Warranty.

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for relevant standards.

**1.4 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. The basis of design is listed herein. Refer to Section 271720 for additional acceptable manufacturers.

**2.2 COPPER BACKBONE - INSIDE PLANT**

- A. CAT 5E Backbone Cable:
  - 1. CAT 5E backbone cable shall link communication equipment rooms serving the building. These CAT 5E backbone cables shall be terminated on modular patch panels
  - 2. Color-coding of the pairs shall be per industry standards for 25-pair cables.
  - 3. CAT 5E backbone cable shall be suitable for installation in free-air, in building risers, in conduit and/or in cable tray and carry a riser CMR or plenum CMP rating. Refer to Section 270500 for project requirements.
  - 4. Basis of Design:
    - a. Belden IBDN25P CMP.

b. Additional acceptable manufacturers:

- 1) Mohawk
- 2) Berk-Tek
- 3) Superior Essex

## 2.3 OPTICAL FIBER BACKBONE - OUTSIDE PLANT

A. Direct Buried (Multimode/Singlemode):

1. This optical fiber cable shall be suitable for direct burial.
2. Optical fiber cable shall incorporate a corrugated steel armor tape to provide for resistance to rodent attack and all other optical fiber cable materials shall be all dielectric (no conductive materials).
3. Optical fiber cable shall be filled with a water-blocking compound.
4. Outer Sheath: Polyethylene (PE). The outer sheath shall be marked with the manufacturer's name, words identifying the cable type (e.g. "Optical Fiber Cable" or "Fiber Optic Cable"), year of manufacture, and sequential length markings. The actual length of the optical fiber cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the optical fiber cable jacket.
5. Temperature Range:
  - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
  - b. Operating: -40°C to +70°C.
6. Humidity Range: 0% to 100%.
7. Maximum Tensile Strength:
  - a. During Installation: 2700 N (600 lb. force) (no irreversible change in attenuation).
  - b. Long Term: 890 N (200 lb. force).
8. Bending Radius:
  - a. During Installation: 20 times cable diameter.
  - b. No Load: 10 times cable diameter.

B. Optical Fiber Pigtails (Multimode):

1. Single-fiber fiber optic pigtails shall be constructed from 50/125 µm multimode (MM) optical fiber of the same grade as the multimode fiber optic backbone cable utilizing tight buffer construction.
2. Fiber optic pigtails shall be factory terminated with a ceramic tipped LC-type connector on one end and shall be a minimum of 5 feet (1.5m) in length or as indicated on the drawings. Channels shall be of equal length.
3. Connector body shall be of materials similar to that used in the proposed couplings. Refer to Section 271500 for connector performance requirements.
4. Provide in quantity to terminate all backbone fiber optic cable strands on each end.
5. Basis of Design:
  - a. Multimode Optical Fiber Pigtails shall be from the same manufacturer as used for the fiber optic termination equipment.

C. Optical Fiber Pigtails (Singlemode):

1. Single-fiber fiber optic pigtails shall be constructed from singlemode (SM) optical fiber of the same grade as the singlemode fiber optic backbone cable utilizing tight buffer construction.
2. Fiber optic pigtails shall be factory terminated with a ceramic tipped LC-type connector on one end and shall be a minimum of 5 feet (1.5m) in length or as indicated on the drawings. Channels shall be of equal length.
3. Connector body shall be of materials similar to that used in the proposed couplings. Refer to Section 271500 for connector performance requirements.
4. Provide in quantity to terminate all backbone fiber optic cable strands on each end.
5. Basis of Design:
  - a. Multimode Optical Fiber Pigtails shall be from the same manufacturer as used for the fiber optic termination equipment.

D. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):

1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.
2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.
3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber connector plugs shall accept 1.6mm - 2.0mm and 3.0mm outside diameter fiber.
5. The average insertion loss is 0.3db for multimode and single mode connectors
6. LC-type optical fiber connector plugs shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2dB
Durability (FOTP-21)	0.2dB
Impact (FOTP-2)	0.2dB
Thermal Shock (FOTP-3)	0.2dB
Humidity (FOTP-5)	0.2dB

7. Additional Performance Requirements:
  - a. Length: 2.23 inches
  - b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
  - a. Multimode Optical Fiber Pigtails shall be from the same manufacturer as used for the fiber optic termination equipment.

## 2.4 OPTICAL FIBER BACKBONE PERFORMANCE

A. OM3 Multimode (MM):

1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.
2. Index Profile: Graded Index.
3. Transmission Windows: 850-nm and 1300-nm.
4. Core Diameter (nom): 50-µm (microns)  $\pm$  2.5.

5. Cladding Diameter:  $125\text{-}\mu\text{m} \pm 1$ .
6. Core-clad Concentricity:  $\leq 1.0\text{-}\mu\text{m}$ .
7. Cladding Non-circularity:  $\leq 1.0\%$ .
8. Fiber Coating Diameter:
  - a.  $245\text{-}\mu\text{m} \pm 10$  (primary coating).
  - b.  $900\text{-}\mu\text{m}$  (nominal) secondary coating (tight buffer)
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
9. Attenuation (maximum @  $23 \pm 5^\circ\text{C}$ ; backbone):
  - a. @ 850-nm: 3.0 dB/km.
  - b. @ 1300-nm: 1.0 dB/km.
  - c. @ 1300-nm thru 1380-nm: 1.0dB/km
    - 1) When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical cable shall not exceed 0.50 dB/km with 80% of the measured fibers not exceeding 0.25 dB/km.
10. Bandwidth (minimum):
  - a. @ 850-nm: 2000 MHz\*km.
  - b. @ 1300-nm: 500 MHz\*km.
11. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

B. Singlemode (SM):

1. Fiber Type: Singlemode; doped silica core surrounded by a concentric glass cladding.
2. Core Diameter: 8 to 9  $\mu\text{m}$ . All optical fibers shall be of the same nominal core diameter and profile.
3. Cladding Diameter:  $125 \pm 1.0 \mu\text{m}$ .
4. Cladding Non-circularity:  $\leq 1\%$ .
5. Core to Cladding Offset:  $\leq 0.8 \mu\text{m}$ .
6. Fiber Coating Diameter:
  - a.  $245 \pm 15\mu\text{m}$  (primary coating).
  - b.  $900\text{-nm}$  (nominal) secondary coating (tight buffer).
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
7. Cut-off Wavelength (cabled fiber; iccf)  $\leq 1260\text{-nm}$ .
8. Mode Field Diameter: 8.3 to 9.8  $\mu\text{m}$  at 1300-nm;  $10.5 \pm 1.0 \mu\text{m}$  at 1550-nm.
9. Zero Dispersion Wavelength ( $\lambda_0$ ): 1301.5 nm less than  $\lambda_0$  less than 1321.5 nm.
10. Zero Dispersion Slope (S0): Less than 0.092 ps/nm<sup>2</sup>\*km.
11. Fiber Attenuation (maximum @  $23 \pm 5^\circ\text{C}$ ; Backbone):
  - a. @ 1300-nm: 2.0 dB/km
  - b. @ 1550-nm: 1.75 dB/km

- 1) When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical fiber cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.
12. Fiber Dispersion (maximum):
- a. @ 1285 to 1330-nm: 3.2-ps/nm\*km
  - b. @ 1550-nm: 18-ps/nm\*km
13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

### **PART 3 - EXECUTION**

#### **3.1 CABLE INSTALLATION REQUIREMENTS**

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room or main equipment room, for backbone and intra-building cable.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

#### **3.2 CROSS-CONNECTS**

- A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.
- B. The Owner shall be responsible for the cross-connect wiring between the horizontal and backbone voice cabling.
  1. All four (4) pairs of the horizontal cable shall be terminated on modular patch panels. Two (2) pairs of the horizontal cable shall be cross-connected to the backbone cable. Refer to the drawings for requirements of the 110 to RJ-45 cross connect cable.
  2. All four (4) pairs in each horizontal cable shall be terminated on 110-type termination blocks in a field dedicated for horizontal cabling. Two (2) pairs of the horizontal cable shall be cross-connected to the backbone cable. 2-pair cross-connect wire, color-coded to identify each pair, shall be used. The 25TH pair position (50th, 75th, etc.) of each riser voice block shall remain vacant.



3. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. All cabling shall be neatly laced, dressed and supported. Avaya 88A retainer clips (or equivalent) shall be used on each 110-type termination block to secure jumper wires on the wiring block(s).
- C. This Contractor shall be responsible for cross-connects between the cabling terminations at the Entrance Room and the telephone utility network point-of-presence. It shall be the responsibility of the Contractor, to work with the Owner and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross-connect documentation, general wiring overview and cable pair identification.

END OF SECTION 271300

## **SECTION 271500 - HORIZONTAL CABLING REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper and optical fiber cabling.

#### **1.2 RELATED WORK**

- A. Section 270500 - Basic Communications Systems Requirements
- B. Section 271720 - Structured Cabling System Warranty

#### **1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for relevant standards and plenum or non-plenum cable requirements.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

#### **1.4 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

### **PART 2 - PRODUCTS**

#### **2.1 HORIZONTAL CABLE**

- A. CAT 6 Cable:
  - 1. The horizontal cable requirements must be met, as well as the following channel requirements.
  - 2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
  - 3. Performance tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.

4. Performance data shall be characterized as "Guaranteed Headroom" and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 271720 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 250 MHz)	Minimum Margin
Insertion Loss:	5%
NEXT:	3.0 dB
PS NEXT:	5.0 dB
ACR-F (ELFEXT):	4.0 dB
PS ACR-F (PS ELFEXT):	5.0 dB
Return Loss:	2 dB

7. The jacket color for CAT 6 cable shall be white for voice applications and blue for data applications.
8. Basis of Design:
  - a. Hubbell HC6R Series
  - b. Additional acceptable manufacturers:
    - 1) Belden
    - 2) Berk-Tek
    - 3) Commscope/Uniprise
    - 4) Panduit
    - 5) Siemon
    - 6) Superior Essex

## 2.2 CONNECTORS/COUPLERS/ADAPTERS

- A. Refer to Section 271100 for requirements and 27 13 00 for requirements.

## 2.3 FACEPLATES/JACKS

- A. CAT 6 Jacks:
  1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
  2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.

3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.
7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
  - a. Match the receptacle color used for other utilities in the building, or
  - b. When installed in surface raceway (if applicable), match the color of that raceway.
8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
  - a. Be a low-profile assembly.
  - b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
  - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
  - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
10. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
12. CAT 6 modular jacks shall be pinned per TIA-568B.
13. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:
  - a. ANSI/TIA/EIA-568-A-5
  - b. ANSI/TIA/EIA-568A
  - c. ISO/IEC 11801
  - d. IEC 603-7
  - e. FCC PART 68 SUBPART F
14. The color for CAT 6 jacks shall be white for voice applications and blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

## 2.4 HORIZONTAL FIBER CABLE

- A. Multimode (MM)/Singlemode (SM):
1. Horizontal optical fiber cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.
  2. Horizontal optical fiber cable shall carry an OFNR (optical fiber non-conductive riser) or OFNP (optical fiber non-conductive plenum) rating. Refer to Section 270500 for project requirements.
  3. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.
  4. Temperature Range:
    - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
    - b. Operating: -40°C to +70°C.
  5. Humidity Range: 0% to 100%.
  6. Maximum Tensile Strength ( $\geq 12$  fibers):
    - a. During Installation: 1332 Newton (300 lb. force) (no irreversible change in attenuation).
    - b. Long Term: 600 N (135-lb. force).
  7. Maximum Tensile Strength ( $\leq 6$  fibers).
    - a. During Installation: 1000 Newton (225 lb. force) (no irreversible change in attenuation).
    - b. Long Term: 100 N (67 lb. force).
  8. Bending Radius:
    - a. During Installation: 20 times cable diameter.
    - b. No Load: 10 times cable diameter.
- B. The horizontal optical fiber cable plant is based on the installation of low strand-count optical fiber cables "fiber to the desk" to be installed from the work area to the communication equipment room serving that area. Refer to the floor plan drawings that identify the location of communication equipment rooms and information outlets. Note that the optical fiber cable count to each information outlet location may vary by location.
- C. Multimode (MM)/Singlemode (SM):
1. Refer to "Horizontal Fiber Performance" in Section 271500 for optical fiber performance parameters.
- D. Basis of Design (MM):
1. Hubbell Optichannel Series
- E. Basis of Design (SM):
1. Hubbell Optichannel Series

## 2.5 HORIZONTAL FIBER PERFORMANCE

### A. Multimode (MM):

1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.
2. Index Profile: Graded Index.
3. Transmission Windows: 850-nm and 1300-nm.
4. Core Diameter (nom): 50- $\mu\text{m}$  (microns)  $\pm 3$ .
5. Cladding Diameter: 125- $\mu\text{m}$   $\pm 2$ .
6. Core-clad Concentricity:  $\leq 3$ - $\mu\text{m}$ .
7. Cladding Non-circularity:  $\leq 2.0\%$ .
8. Fiber Coating Diameter:
9. 250- $\mu\text{m}$   $\pm 15$  (primary coating)
  - a. 900- $\mu\text{m}$  (nominal) secondary coating (tight buffer)
  - b. All coatings shall be mechanically strippable without damaging the optical fiber.
10. Attenuation (maximum @ 23 $\pm$ 5°C; backbone):
  - a. @ 850-nm: 3.0 dB/km
  - b. @ 1300-nm: 1.0 dB/km
  - c. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the cable shall not exceed 0.50 dB/km with 80% of the measured optical fibers not exceeding 0.25 dB/km.
11. Bandwidth (minimum):
  - a. @ 850-nm: 500 MHz\*km
  - b. @ 1300-nm: 500 MHz\*km
12. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

### B. Singlemode (SM):

1. Singlemode; doped silica core surrounded by a concentric glass cladding.
2. Core Diameter: 8-9  $\mu\text{m}$ . All optical fibers shall be of the same nominal core diameter and profile.
3. Cladding Diameter: 125 $\pm$ 1.0  $\mu\text{m}$ .
4. Cladding Non-circularity:  $\leq 1\%$ .
5. Core to Cladding Offset:  $\leq 0.8$   $\mu\text{m}$ .
6. Fiber Coating Diameter:
  - a. 245 $\pm$ 15  $\mu\text{m}$  (primary coating)
  - b. 900-nm (nominal) secondary coating (tight buffer)
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
7. Cut-off Wavelength (cabled fiber;  $\lambda_{\text{ccf}}$ ) less than 1260-nm.
8. Mode Field Diameter: 8.3 - 9.8  $\mu\text{m}$  at 1300-nm; 10.5 $\pm$ 1.0  $\mu\text{m}$  at 1550-nm.
9. Zero Dispersion Wavelength ( $\lambda_0$ ): 1301.5 nm less than 10 less than 1321.5 nm.
10. Zero Dispersion Slope ( $S_0$ ):  $\leq 0.092$  ps/nm<sup>2</sup>\*km.

11. Fiber Attenuation (maximum @ 23±5°C; Backbone):
  - a. @ 1300-nm: 2.0 dB/km
  - b. @ 1550-nm: 1.75 dB/km
  - c. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.
12. Fiber Dispersion (maximum):
  - a. 1285-1330-nm: 3.2-ps/nm\*km
  - b. @ 1550-nm: 18-ps/nm\*km
13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

## 2.6 COPPER WORK AREA CORDS

- A. RJ-45:
  1. Provide the same quantity of Category 6 copper work area cords as copper patch panel cords specified in Section 271100. Copper work area cords shall be equipped with an 8-pin modular RJ-45 connector on each end.
  2. Work area cords shall be 10' in length.
  3. Manufacturer of copper patch cable shall be the same as the manufacturer of the horizontal copper cable.

## PART 3 - EXECUTION

### 3.1 CABLE INSTALLATION REQUIREMENTS

- A. Horizontal Cabling:
  1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.
  2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.
  3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
  4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.
  5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.

6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
  7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
- B. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
1. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
    - a. Twelve (12) inches from power lines of less than 5-kVa.
    - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
    - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    - d. Thirty-nine (39) inches from transformers and motors.
  2. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.
- C. Horizontal Cabling in Modular Furniture:
1. This Contractor shall be responsible for providing and installing cable completely to the information outlet in the furniture. This Contractor's responsibility does not end at the furniture feed point.
  2. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via conduit.
  3. Where modular furniture is installed without wall contact, the Contractor shall install cabling through floor fittings as shown on the drawings.
  4. Cabling shall be protected in the transition from the floor or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the Floor and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.
  5. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
  6. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and information outlets. The panels shall be marked prior to installation by the Owner to identify the desired location of the information outlets.
  7. The information outlet shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the information outlet to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.



### 3.2 CABLE TERMINATION REQUIREMENTS

#### A. Cable Termination - CAT 3 Voice Horizontal Cabling:

1. Voice pairs shall terminate on wall-mounted 110-type termination blocks at the entrance room, main equipment room and/or telecommunications rooms.
2. If the "last" Horizontal termination block is greater than 50% utilized, one additional block shall be provided for future use.
3. The Contractor shall furnish and install cable management hardware (e.g., D-rings and cable guides) to neatly and securely route the cable from the nearest cable tray to the cable termination hardware.
4. The height of the voice termination field shall not exceed 6 feet (72 inches) above floor level to facilitate cable maintenance.
5. Cables shall be fed from below the termination hardware in a manner that will facilitate growth.
6. Horizontal troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of and between each column of termination blocks. Rings shall be positioned between the backbone and horizontal blocks for vertical routing of jumpers and/or cross-connect wiring.
7. Termination of horizontal voice cabling shall be accomplished by using 4-pair (e.g., C4-type) clips. The 25<sup>th</sup> of each row on the 110-type termination block located in the telecommunication room shall not be used for termination of horizontal voice cable.
8. Termination of backbone voice cabling shall be accomplished by using 5-pair (e.g., C5-type) clips.
9. The Contractor shall ensure that the twists in each cable pair are preserved to within 1.0 inch of the termination for all voice UTP cables. The cable jacket shall be removed only to the extent required to make the termination.
10. A jumper wire spool holder shall be installed at the main equipment room. Two full 1000-foot (305 meter) spools of 24 AWG one-pair jumper wire, one spool each of white-blue/blue and white-green/green, shall be supplied with the holder. The spool holders shall be assemblies designed for that purpose.

#### B. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

#### C. Cable Terminations - Fiber Optic:

1. ALL fibers shall be terminated using the specified connector type.
2. All terminated fibers at the telecommunications rooms shall be mated to couplings mounted on panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
3. All couplings shall be fitted with a dust cap.
4. Fibers from multiple locations may share a common enclosure, however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall NOT share a common connector panel (e.g., "insert").

5. Slack in each fiber shall be provided to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (approximately 39") of slack shall be retained regardless of panel position relative to the potential work area.

END OF SECTION 271500

## SECTION 271710 - TESTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

#### 1.2 RELATED WORK

- A. Section 270500 - Basic Communications Systems Requirements

#### 1.3 QUALITY ASSURANCE

- A. Refer to Section 270500 for relevant standards.

#### 1.4 SUBMITTALS

- A. Under the provisions of Section 270500 and Division 1, prior to the start of work, the Contractor shall submit:
  1. Complete information on testing procedure as described herein.
  2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

### PART 2 - PRODUCTS

#### 2.1 TESTING COPPER

- A. General Requirements:
  1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
  2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
  3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
  4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
  5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
  6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.

7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
  - a. CAT 6 Cable:
    - 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
    - 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
    - 3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link", including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
      - a) Wire Map
      - b) Length
      - c) NEXT Loss (Pair-to-Pair)
      - d) NEXT (Power Sum)
      - e) ELFEXT (Pair-to-Pair)
      - f) ELFEXT (Power Sum)
      - g) Return Loss
      - h) Attenuation
      - i) Propagation Delay
      - j) Delay Skew
    - 4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.
    - 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
    - 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS\*, FAIL\*, or FAIL result for any of the parameters will not be accepted.

- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

## 2.2 TESTING FIBER

### A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
  - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
  - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.

- B. Tests Prior to Installation: The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.

- C. Tests After Installation: Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:
1. Optical Attenuation ("Insertion Loss" Method):
    - a. Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at  $850 \pm 30$  nm. Singlemode optical fibers (if applicable) shall be tested at  $1300 \pm 20$  nm.
    - b. Attenuation of optical fibers shall not exceed the values calculated as follows:
      - 1) Attenuation (max.) =  $2 * C + L * F + S$  dB.
      - 2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices \* maximum attenuation per splice).
  2. Verification of Link Integrity (OTDR):
    - a. All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.
    - b. Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
    - c. OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

### 2.3 DOCUMENTATION/AS-BUILTS/RECORDS

- A. General:
1. Upon completion of the installation, submit as-builts per the requirements of Section 270500 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

**PART 3 - EXECUTION (Not Used)**

END OF SECTION 271710

**SECTION 271720 - STRUCTURED CABLING SYSTEM WARRANTY****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

**1.2 RELATED WORK**

- A. Section 270500 - Basic Technology Systems Requirements.
- B. Section 271100 - Communication Equipment Room (CER).
- C. Section 271300 - Backbone Cabling Requirements.
- D. Section 271500 Horizontal Cabling Requirements.

**1.3 QUALITY ASSURANCE**

- A. Refer to Section 270500 for relevant standards.

**1.4 SUBMITTALS**

- A. Under the provisions of Section 270500 and Division 1, prior to close of the project the Contractor shall submit:
  - 1. A numbered certificate from the manufacturing company registering the installation.

**PART 2 - PRODUCTS****2.1 WARRANTY**

- A. A twenty (20) year Product Installation Warranty shall be provided for the structured cabling system as described in the contract documents.
- B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).
- C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.
- D. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.



**PART 3 - EXECUTION**

**3.1 WARRANTY REQUIREMENTS**

- A. This Contractor shall be responsible for providing, installing and testing a structured cabling system that will meet the manufacturer's warranty requirements.

END OF SECTION 271720

**SECTION 280500 - BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

**1.2 SCOPE OF WORK**

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make the portion of the security systems a finished and working system.
- C. Separate contracts will be awarded for the following work.
- D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- E. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the Construction Manager's scope statements for complete scope of work description.
- F. Description of systems include but are not limited to the following:
  - 1. Electronic access control system
  - 2. Electronic intrusion detection system
  - 3. Video surveillance
  - 4. Fire detection and alarm.
  - 5. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
  - 6. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
  - 7. Firestopping of penetrations of fire-rated construction as described in Section 280503.

**1.3 OWNER FURNISHED PRODUCTS**

- A. Antenna Tower.
- B. Uninterruptible Power Supply (UPS).
- C. Powered Furniture in Radio Room.

#### 1.4 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. Itemize all work and list associated hours and pay scale for each item.

#### 1.5 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
- B. Definitions:
  - 1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
  - 2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
  - 3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
  - 4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.
- C. General:
  - 1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, cable tray, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
  - 2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.
  - 3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
  - 4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

- a. Lighting Fixtures
- b. Gravity Flow Piping, including Steam and Condensate
- c. Sheet Metal
- d. Electrical Busduct
- e. Cable Trays, including 12" access space
- f. Sprinkler Piping and other Piping
- g. Conduit and Wireway
- h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Security Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

## 1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

- b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
- a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
- B. Participation:
- 1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
  - 2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
  - 3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of applicable drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
- C. Drawing Requirements:
- 1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    - a. Scale of drawings:
      - 1) General plans: 1/4 Inch = 1 '-0" (minimum).

- 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
  - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
  - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
  - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
  3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
  4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.7 QUALITY ASSURANCE

### A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
  - a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

### B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Lee's Summit, Missouri Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

### C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
  - a. Factory Mutual
  - b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:

1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.



- F. Field Measurements:
1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

## 1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item	Coordination Drawings
28 05 03	Through-Penetration Firestopping Fire Alarm and Detection Systems	
28 31 01	Addressable	

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

- c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
  - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 28 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 28 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

## 1.9 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.

## C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
  - a. Material: Delivered cost of product with taxes paid.
  - b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
  - a. Overhead and profit.
  - b. Bonds.
  - c. Insurance.
  - d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
  - a. Security systems:
    - 1) Surveillance
    - 2) Access control
    - 3) Intrusion
    - 4) Infant abduction

## D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

**1.10 CHANGE ORDERS**

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.
- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

**1.11 EQUIPMENT SUPPLIERS' INSPECTION**

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
  1. Firestopping, including mechanical firestop systems.

**1.12 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE**

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site to prevent damage.
- C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

**1.13 NETWORK / INTERNET CONNECTED EQUIPMENT**

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

**1.14 WARRANTY**

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
- B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

**1.15 INSURANCE**

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

**1.16 MATERIAL SUBSTITUTION**

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

## **PART 2 - PRODUCTS**

### **2.1 Refer to individual sections.**

## **PART 3 - EXECUTION**

### **3.1 JOBSITE SAFETY**

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### **3.2 GENERAL INSTALLATION REQUIREMENTS**

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 260533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

### 3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

### 3.4 PROJECT CLOSEOUT

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
2. Refer to the end of this section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; submit receipt to Architect/Engineer prior to final payment being approved.

### 3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div28.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.



8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- F. Refer to the individual specification sections for minimum hours of instruction time for each system.

- G. Operating Instructions:
1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
  2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM STARTING AND ADJUSTING

- A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.
- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record actual routing of all conduits sized 2" or larger.

- E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

**3.9 ADJUST AND CLEAN**

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

- 1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
- 2. All mechanical firestop products are installed and all other penetrations have been sealed.
- 3. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
- 4. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

Prime Contractor: \_\_\_\_\_ By: \_\_\_\_\_

Requested Observation Date \_\_\_\_\_ Today's Date: \_\_\_\_\_

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

END OF SECTION 280500

**SECTION 280503 - THROUGH PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Through-Penetration Firestopping.

**1.2 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

**1.3 REFERENCES**

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. HCAI - Health Care Access and Information (California)
- J. The Building Officials and Code Administrators National Building Code
- K. 1997 Uniform Building Code
- L. Wisconsin Administrative Code
- M. 2018 International Building Code
- N. NFPA 5000 - Building Construction Safety Code

**1.4 SUBMITTALS**

- A. Submit under provisions of Section 280500.
- B. Submit Firestopping Installers Certification for all installers on the project.

- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.
- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.
  - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  - 4. F ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

### **1.6 PERFORMANCE REQUIREMENTS**

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
  - 2. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. at both ambient temperature and 400°F.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.8 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Products Division
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk
  4. Tremco; Sealant/Weatherproofing Division
  5. Johns-Manville
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems
  9. Wiremold/Legrand: FlameStopper
  10. Dow Corning Corp
  11. Fire Trak Corp
  12. International Protective Coating Corp

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.

- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:
1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:
    - a. F Rating = Floor/Wall Rating
    - b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:
  - a. F Rating = Wall Rating
  - b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	



3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

- a. F Rating = Wall/Floor Rating
- b. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.

- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### **3.3 CLEANING AND PROTECTING**

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### **3.4 IDENTIFICATION**

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### **3.5 INSPECTION**

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 280503

**SECTION 283101 - FIRE ALARM AND DETECTION SYSTEMS ADDRESSABLE****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Fire alarm and detection systems.
- B. One-way emergency communications system with voice notification within-building, coverage.

**1.2 RELATED WORK**

- A. Section 260553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

**1.4 REFERENCES**

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 72 - National Fire Alarm and Signaling Code
- C. NFPA 101 - Life Safety Code
- D. UL 2017 - General Purpose Signaling Devices and Systems
- E. UL 217 / 268 - Standard for Smoke Alarms / Smoke Detectors for Fire Alarm Systems
- F. UL 2572 - Control and Communication Units for Mass Notification Systems

**1.5 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 260500 and as noted below.
  - 1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.
  - 2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.

- B. Provide product catalog data sheets as shop drawings.
  - 1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.
  - 2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
  - 3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.
- C. Submit CAD Floor Plans as Shop Drawings:
  - 1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.
  - 2. Indicate the precise routing of notification appliance circuits under the provisions of circuit survivability. Refer to "Wiring" under Part 3 - Execution of this specification section for requirements.
  - 3. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.
- D. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- E. Provide installation and maintenance manuals under provisions of Section 260500.
- F. Submit manufacturer's certificate that system meets or exceeds specified requirements.
- G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- H. Voice Alarm Communication System: Submit equipment rack or console layout, grounding schematic, amplifier power calculations, and wiring diagram.
- I. Incident Commander Display: Submit sample display screen layouts and list of functions for Authority Having Jurisdiction (AHJ) review and coordination.
- J. Emergency Communication System: Submit equipment rack or console layout, grounding schematic, amplifier power calculations, and wiring diagram.
- K. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.
- L. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

## 1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
  - a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
  - b. Notification Appliances: Speakers, speaker strobes, and strobes.
2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet minimum of one (1) set each and shall turn over to the Owner upon completion.
3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."
4. Portable Firefighter Emergency Handset Phones: Provide 5. Locate in the room with the main fire alarm panel.

### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver products to site under provisions of Section 260500.
- B. Store and protect products under provisions of Section 260500.

### **1.8 REGULATORY REQUIREMENTS**

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

### **1.9 SYSTEM DESCRIPTION**

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.

- D. In-Building Network: A complete fire alarm system network shall be provided. Provide quantity of control panels as indicated on the drawings. The network shall be a Style 7 token ring, peer-to-peer network. The network shall be characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit or communication channel. The distributed intelligent characteristic of the network shall provide for all nodes independently making pertinent system decisions with no need for a central controller. Each node shall be capable of independent operation should loss of network communications occur. In no case shall read-only network annunciation be acceptable as the only networking function.
- E. Firefighter Phone System: A two-way talk path shall be provided for the fire department's use from the voice command center to the secondary fire alarm attack entrances, elevator lobbies, primary and backup power rooms and the entrance to all enclosed stairways.
- F. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- G. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
- H. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
- I. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

#### **1.10 PROJECT RECORD DOCUMENTS**

- A. Submit documents under the provisions of Section 260500.
- B. Include location of end-of-line devices.
- C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

#### **1.11 OPERATION AND MAINTENANCE DATA**

- A. Submit data under provisions of Section 260500.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include results of testing of all devices and functions.
- D. Include manufacturer's representative's letter stating that system is operational.
- E. Include the CAD floor plan drawings.

- F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

#### **1.12 DOCUMENT STORAGE CABINET**

- A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard size business card with service contact information.
  - 1. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.
- B. The cabinet shall be red in color with an identification label reading "FIRE ALARM DOCUMENTS". Refer to Identification Section 260553. The cabinet shall be lockable. Minimum cabinet size shall be 14" x 14" x 48".
- C. The final version of the system database program shall be stored within the cabinet.
- D. Locate cabinet in the main electrical room.

#### **1.13 WARRANTY**

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

#### **1.14 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT**

- A. Provide cost to furnish service, inspect, and test all devices of the fire alarm system per the requirement of NFPA for one (1) year, starting one year after the Date of Substantial Completion. Submit written reports of inspection testing per NFPA 72, Chapter 14.
- B. Provide an alternate cost for a complete inspection/testing and service/maintenance contract for the fire alarm system for one (1) year two (2) years, starting one year after the Date of Substantial Completion. Submit sample contract terms and conditions for review with shop drawings.
- C. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Johnson Controls - Simplex
- B. Notifier by Honeywell

- C. Edwards - EST
- D. Siemens Fire Safety
- E. Gamewell - FCI
- F. Microm Technologies

## 2.2 FIRE ALARM CONTROL PANEL (FAP)

- A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
- B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:
  - 1. Minimum Total Addressable Points: 500
  - 2. Minimum Total SLC Loops (including board, ready for field connections): 4
  - 3. Panel Expansion Capability, Minimum Total SLC Loops: 10
  - 4. Minimum Node Capacity for Network System: 100
- C. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:
  - 1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
  - 2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
- D. Central Processing Unit:
  - 1. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.
  - 2. All power for the unit shall be supervised and supplied by the FAP.
- E. Display:
  - 1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
  - 2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
  - 3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.



4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.

F. Power Supply:

1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated emergency branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 260553.
2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
3. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

G. Surge Protection:

1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 260553. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.

H. Dual Digital Communicator:

1. Communicator shall be fully supervised and shall operate on loop start phase lines ahead of the building PBX system.
2. Approvals: UL listed - UL 864/NFPA 72, FM approved.

### **2.3 FIRE ALARM PATHWAY CLASS AND SURVIVABILITY LEVEL**

A. Pathway Class:

1. Pathway Class B: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

B. Pathway Survivability Level:

1. Pathway Survivability Level 0: Circuits have no requirements for pathway survivability beyond the requirements of the code.

### **2.4 EMERGENCY COMMUNICATION CONTROL UNIT (ECCU)**

- A. The ECCU shall be a listed combination system with the fire alarm system as described in NFPA 72 and meeting UL Standard 864.

- B. Microphone for delivering live voice messages. Ability to interrupt public address system announcements and to silence building background music while delivering voice messages.
- C. Available for use for general paging or other non-emergency messages without the activation of strobes.
- D. ECCU shall be able to activate strobes and discrete output for text signs.
- E. Capacity for multiple prerecorded messages. Prerecorded messages shall be passed in the English language and also in the predominant language(s) used. Messages should address at least the following:
  - 1. Bomb threat or actual bomb within/around the building.
  - 2. Intruder/hostile person sighted within/around the building.
  - 3. Occupants directed to take cover within the building.
  - 4. Evacuation of the building using exits other than the normal main entrance/exit (since the front entrance/exit is often a location targeted by terrorists).
  - 5. Emergency weather conditions appropriate for the local area.
  - 6. "All Clear" message.
  - 7. A test message intended for verifying functionality of the system.
- F. Ability to automatically repeat prerecorded messages until terminated.
- G. Allows the ECS to temporarily override fire alarm audible messages and provide intelligible voice commands during simultaneous fire and terrorist events. All other features of the fire alarm system, including the transmission of signals to the fire department, shall function properly.
- H. Provide a supervisory signal if the ECS is used to override fire alarm audible messages during simultaneous fire and terrorist events. The supervisory signal shall be annunciated at the FACP and any remote fire alarm annunciators, and be transmitted to the fire department. The visual annunciation of the separate supervisory signal shall be distinctly labeled or otherwise clearly identified.
- I. Provide single switch or operating mechanism capable of turning off or on the system's white/clear strobes. The switch shall function as a "dead-man" type to turn off the strobes.
- J. Provide a 3-position switch to allow manual control on/off of strobes; center return to automatic mode.
- K. Provide a single switch or operating mechanism capable of shutting down all heating, ventilating, and air conditioning (HVAC) equipment in the facility.
- L. Complete set of self-diagnostics for the controller and appliance network. Local diagnostic information display, information, and system event log file.
- M. Interfaces to LOC for initiating recorded messages and delivering live voice messages from locations in the building other than at the ECCU.
- N. Establishes priority for passing messages to prevent interference between the ECCU, LOC, and the wide-area notification.

**2.5 LOCAL OPERATING CONSOLE (EMERGENCY COMMUNICATION) (LOC)**

- A. Wall-mounted enclosure with tamper wire seal to minimize the potential of operation by unauthorized personnel.
- B. Supplemental heating of enclosures in unconditioned areas.
- C. A microphone station that emulates operation of the ECS from the ECCU.
- D. Individual manual activation pushbuttons to activate the ECS prerecorded messages.
- E. Provide visual notification when ECS functions have been temporarily disabled during fire and ECS events.
- F. Provide a 3-position switch to allow manual control on/off of strobes; center return to automatic mode.
- G. Provide a single switch or operating mechanism capable of shutting down all heating, ventilating, and air conditioning (HVAC) equipment in the facility.
- H. Command Center or local operator console (LOC) with redundant audio messages, paging microphone, and request for control switches and status indicators. Each Command Center shall have switches with LED annunciators for the following:
  - 1. Request to take control
  - 2. Request accepted
  - 3. Request denied
  - 4. Restore Command Center to automatic operation
  - 5. Priority request override

**2.6 FIRE ALARM TERMINAL CABINET (FATC)**

- A. Fire Alarm Terminal Cabinet with locked hinged door. Provide as an extension of the main fire alarm system.

**2.7 FIREFIGHTER'S SMOKE CONTROL PANEL (SCP)**

- A. Panel shall include manual control or override of automatic control for mechanical smoke control systems. The control unit shall comply with UL 864 UUKL and be listed as smoke control equipment.
- B. The firefighter's control panel shall provide control capability over the complete smoke-control systems equipment within the building as follows:
  - 1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes, and other operating equipment used or intended for smoke control purposes. ON position shall be wired in parallel with any other control, and OFF position shall be wired in series to interrupt all other controls. AUTO position shall allow other controls to automatically operate.
  - 2. OPEN-AUTO-CLOSE control over individual dampers relating to smoke control and that are also controlled from other sources within the building. OPEN shall be wired in parallel with any other control, and CLOSE shall be wired in series to interrupt all other controls. AUTO position shall allow other controls to automatically operate. Dampers shall have end limit switches to prove and indicate position.

3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the firefighter's control panel. OPEN shall be wired in parallel with any other control, and CLOSE shall be wired in series to interrupt all other controls.
- C. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone, and by LED indicators as follows:
1. Fans, Dampers, and Other Operating Equipment in their Normal Status: WHITE.
  2. Fans, Dampers, and Other Operating Equipment in their Off or Closed Status: RED.
  3. Fans, Dampers, and Other Operating Equipment in their On or Open Status: GREEN. Indication shall be from end limit switches on dampers and fan current sensing relay.
  4. Fans, Dampers, and Other Operating Equipment in a Fault Status: YELLOW/AMBER.
- D. Momentary pushbutton shall be provided for simultaneous testing of all LEDs.
- E. A permanent, clear, and concise diagram showing the fans within the building and indication of the direction of airflow and the relationship of components shall be displayed on a graphical section of the building. Graphics shall be non-glare.
- F. All field wiring shall terminate on modular screw clamp terminals or UL864-UUKL listed electronics mounted in the enclosure.
- G. Smoke Control Panel Control Operation:
1. Stairway Pressurization System:
    - a. Automatic operation shall be as described in Article 3.1. Refer to mechanical drawing STAIRWELL PRESSURIZATION CONTROL DIAGRAM and sequence of operation. If selector switch is in AUTO position, the status indicators shall be WHITE.
    - b. Manual operation shall be initiated by a selector switch in the smoke control panel. Selector switch position shall override all other H-O-A or automatic controls. If switch is ON and pressure differential switch proves airflow, status indicators shall be GREEN. If switch is in OFF position and pressure differential switch proves no airflow, status indicators shall be RED.
    - c. If the above operations do not occur within 30 seconds or if the fire alarm monitoring of the stairwell pressurization system initiates a Trouble alarm, the status indicator shall be YELLOW. The fire alarm monitoring of the stairwell pressurization system includes the following:
      - 1) If stairwell pressurization monitoring of local disconnect is off.
      - 2) Loss of power at controller.
      - 3) Controller fault.
      - 4) Hand-Off-Auto is in the off position.
  2. Atrium Smoke Purge System:
    - a. Automatic operation shall be as described in Article 3.1. Refer to mechanical drawing SMOKE PURGE CONTROL DIAGRAM and sequence of operation. If selector switch is in AUTO position, the status indicators shall be WHITE.

- b. Manual operation shall be initiated by a selector switch in the smoke control panel. Selector switch position shall override all other H-O-A or automatic controls. If switch is ON and pressure differential switch proves airflow, status indicators shall be GREEN. If switch is in OFF position and pressure differential switch proves no airflow, status indicators shall be RED.
  - c. If the above operations do not occur within 30 seconds or if the fire alarm monitoring of the smoke purge system initiates a Trouble alarm, the status indicator shall be YELLOW. The fire alarm monitoring of the smoke purge system includes the following:
    - 1) If smoke purge system monitoring of local disconnect is off.
    - 2) Controller fault.
    - 3) Hand-Off-Auto is in the off position.
    - 4) Loss of power at dampers, doors or windows used for makeup air.
3. High Rise Fire Floor Containment Sequence:
- a. Automatic operation shall be as described in Article 3.1. Refer to mechanical drawing SMOKE PURGE CONTROL DIAGRAM and sequence of operation. If selector switch is in AUTO position, the status indicators shall be WHITE.
  - b. Manual operation shall be initiated by a selector switch in the smoke control panel. Selector switch position shall override all other H-O-A or automatic controls. If switch is ON and pressure differential switch proves airflow, status indicators shall be GREEN. If switch is in OFF position and pressure differential switch proves no airflow, status indicators shall be RED.
  - c. If the above operations do not occur within 30 seconds or if the fire alarm monitoring of the smoke purge system initiates a Trouble alarm, the status indicator shall be YELLOW. The fire alarm monitoring of the smoke purge system includes the following:
    - 1) If smoke purge system monitoring of local disconnect is off.
    - 2) Loss of power at controller.
    - 3) Loss of power at dampers, doors, or windows used for makeup air.

## 2.8 SIGNALING LINE CIRCUIT DEVICES

- A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.
- B. Signal Line Device(s):
  - 1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    - a. Device type as follows:
      - 1) W = Weather Proof
      - 2) WG = Wire guard is required
      - 3) Candela Ratings:
        - a) ## = 15 Candela, 30 Candela; 75 Candela; 110 Candela; 177 Candela
        - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.

b. Sequence of operation as follows:

- 1) A = Atrium
- 2) CA = Clean Agent System
- 3) CR = Computer Room
- 4) E = Elevator Recall
- 5) D = HVAC Control
- 6) DH = Door Hold Release
- 7) DIPS = Dual Interlock Pre-Action System
- 8) FD = Fire Door Release
- 9) MP = Medical Procedure Room
- 10) S = Sleeping / Patient Room
- 11) SW = Stairwell

C. FA-120; Smoke Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

a. Device types as follows:

- 1) Blank = Photoelectric
- 2) AT = Attic (located in)
- 3) BR = Beam Receiver
- 4) BT = Beam Transmitter
- 5) CO = Combination Smoke / Carbon Monoxide
- 6) COH = Combination Smoke / Carbon Monoxide / Heat
- 7) COS = Combination Smoke / Carbon Monoxide / Strobe
- 8) H = Combination Smoke / Heat Detectors
- 9) ION = Ionization Type
- 10) ID = In-Duct Detector
- 11) SB = Sounder Base
- 12) SV = Stand Alone with Sounder and 177 Candela Strobe

2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. (BR) and (BT) Projected Beam Type Detectors: This device shall utilize photoelectric analog smoke sensor technology. Provide with transmitter and associated receiver. Microprocessor-based detector shall provide a minimum of eight sensitivity levels, temperature and dirt compensation, and automatic gain control. Sensor to contain beam alignment adjustments and receiver calibration.
  - a. Detector shall connect directly to an SLC loop or shall be provided with multiple monitor modules, as required, to connect to the SLC loop and for monitoring alarm and trouble output contacts. The detector shall be provided complete with all mounting hardware provided and installed where indicated on the drawings.
  - b. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided.
  - c. Provide with remote indicator panel providing LED indications of alarm and trouble.

4. (CO) Combination Smoke / Carbon Monoxide:
  - a. Multi-criteria sensor for photoelectrical smoke sensing and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
  - b. The combined photoelectric smoke detection CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.
  - c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.
  - d. The detector shall use only one address on the SLC.
  - e. CO sensor cartridge element shall be field replaceable.
5. (COH) Combination Smoke / Carbon Monoxide/Heat Detector:
  - a. Multi-criteria sensor for photoelectrical smoke sensing, heat and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
  - b. The combined photoelectric smoke detection / heat / CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.
  - c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.
  - d. The detector shall use only one address on the SLC.
  - e. CO sensor cartridge element shall be field replaceable.
6. (COS) Combination Smoke / Carbon Monoxide/ Strobe Detector:
  - a. Multi-criteria sensor for photoelectrical smoke sensing, carbon monoxide (CO) detection, and 177 Candela strobe. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
  - b. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.
  - c. The detector shall use only one address on the SLC.
  - d. CO sensor cartridge element shall be field replaceable.
7. (H) Combination Smoke / Heat Detector:
  - a. Multi-criteria sensor for photoelectrical smoke sensing and rate of rise heat detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
  - b. The detector shall use only one address on the SLC.
8. (ION) Analog Ionization Type Sensor: Shall use the dual chamber ionization principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
9. (IN) In-Duct Smoke Detectors:
  - a. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.

- b. Analog Ionization Type Sensor: Shall use the dual chamber ionization principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
  - c. Low Flow Type: Listed for use in duct with 0-2000 feet per minute velocity.
  - d. Each smoke detector shall connect directly to an SLC loop.
  - e. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided to match the duct application. Provide a two-piece head/base design.
  - f. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
  - g. Provide a remote LED indicator device (FA-240/241), mounted in ceiling directly below detector with a single-gang faceplate labeled: Duct Smoke Detector.
10. (SA) Stand Alone with Horn:
- a. 120 VAC with 9V battery backup (batteries supplied by Contractor), photoelectric type, integral test switch, Form A/Form C contacts, 90 dB piezo solid-state horn, low/missing battery alarm, pulsing LED sensing chamber, insect screen, LED condition indicator, UL 217 listed.
  - b. Approved Manufacturers:
    - 1) Gentex 9120 Series
    - 2) System Sensor
    - 3) Fenwall
    - 4) Kidde
11. (SB) Analog Photoelectric Type Sensor with Sounder Base
12. (SV) Stand Alone with Sounder and 177 Candela Strobe:
- a. 120 VAC with 9V battery backup (batteries supplied by Contractor), photoelectric type, integral 177 Candela strobe, integral test switch, Form A/Form C contacts, 90 dB piezo solid-state horn, low/missing battery alarm, pulsing LED sensing chamber, insect screen, LED condition indicator, UL 217 listed.
  - b. Approved Manufacturers:
    - 1) Gentex 9120 Series
    - 2) Fenwall
    - 3) Gamewell
    - 4) Kidde
13. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.
14. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
15. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
16. A test means shall be provided to simulate an alarm condition.
17. Audible Sounder Detector Base for Sleeping Room Applications:
- a. The audible base shall sound an alarm in the local room in UL2017 operation and UL484 for general evacuation. The unit shall be programmable by the main control panel for the duration of operation.
  - b. The audible sounder base shall sound Temporal 3 (fire) or Temporal 4 (CO alarm) and be at 75 dB at 10 feet.



## D. FA-121; Gas Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) CO = Carbon Monoxide
2. (CO) Analog Carbon Monoxide Type Sensor.

## E. FA-122; Duct Smoke Detectors, Sampling Tube Type:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) # = Equipment or system
  - b. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
  - c. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
  - d. Provide a remote alarm LED indicator device (FA-241) or (FA-242) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

## F. FA-140; Heat Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Combination Rate of Rise / Fixed Temp
    - 2) AT = Attic (located in)
    - 3) F = Fixed Temp
    - 4) X = Explosion Proof
2. (BLANK) Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
  - a. MRI Procedure Rooms: Analog fixed temperature type sensor suitable for magnetic environments, factory programmed to alarm at 135°F or as specified on drawings. Sensor shall report to the fire alarm control panel via an addressable relay installed outside the magnetic shield. Coordinate the magnetic filter for the fire alarm conductors with the MRI shield vendor.

3. (F) 200°F fixed temperature. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
4. (RC) Rate Compensated
5. (X) Explosion-Proof: Combination rate of rise and 135°F fixed temperature. Non-current carrying metal enclosure. Hazardous Classification: Class I. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
6. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
7. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
8. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
9. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
10. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
11. A test means shall be provided to simulate an alarm condition.
12. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

G. FA-141; Heat Detector, Linear Wire Type:

1. Linear heat detector with addressable monitor module (FA-160) and line type heat detector conductor routed as shown on drawings.
2. Manufacturer: Protectowire, fire alarm manufacturer.
3. Labeling: Provide signage identification indicating existence of linear heat detectors at the entrances of areas protected.

H. FA-151; Flame Detector:

1. Microprocessor based design. infrared type detector. Swivel mount. Provide with anti-contaminant air shields and a remote test switch located at the fire alarm control panel. Provide two addressable monitor modules for monitoring alarm and fault output contacts.

I. FA-160; Monitor Modules:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Refer to Plans
    - 2) KB = Knox Box Monitor
2. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor Option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
3. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.

4. The module shall supply the required power to operate the monitored device(s).
5. The module shall provide address setting means using rotary decimal or DIP switches.

J. FA-161; Addressable Control Module:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Refer to Plans
    - 2) DH = Door Hold Open
    - 3) PD = Hold Open Override
2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

K. FA-280; Isolation Module:

1. Provide fault isolation modules or isolator detector base capable of isolating and removing the fault from Class A or Class X addressable loop data circuits while allowing the remaining data loop to continue operation. Provide a minimum of two isolation modules or bases and between every 15 devices.

L. MRI Environments:

1. MRI environments require special consideration for fire alarm devices. An addressable fire alarm device will not operate appropriately. The designer should discuss options with the client based on the cost of the system. Common options include:
  - a. \$ Cost - (Gray dome) Analog heat detector installed in magnet room with wiring exiting room through the waveguide filter to an addressable relay in the MRI equipment room. (Con is device rating is nearly the same as sprinkler head.)
  - b. \$\$ Cost - Duct mounted smoke detector mounted in return ducts within 3' of exiting magnetic room shield. Install remote test/reset switch in ceiling just below duct detector(s).
  - c. \$\$\$ Cost - Aspirating smoke detection system (Vesda) installed in room.

## 2.9 NOTIFICATION APPLIANCE DEVICES

- A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

## B. Notification Appliance Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) W = Weather Proof
    - 2) WG = Wire guard is required
    - 3) Candela Ratings:
      - a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela
      - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
  - b. Sequence of operation as follows:
    - 1) S = Sleeping / Patient Room

## C. Notification Device(s):

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: White housing with red lettering or pictogram.

## D. FA-200; Visual Alarm Devices:

1. Wall or ceiling mounted, refer to plans.
2. High intensity (Candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
5. (W) Weatherproof Visual Notification Device: High intensity strobe, square housing, 75 Candela rating, suitable for wet locations. Provide with weatherproof back box.
  - a. Mounting: Semi-flush wall.
  - b. Conduit shall not be exposed.

## E. FA-210; Audio Horn Alarm Devices:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
2. Device types as follows:
  - a. M = Mini-Horn
3. Wall or ceiling mounted, refer to plans.
4. Sound Rating: 85 dB at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
5. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.
6. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

7. (M) Mini-Horn Audio Notification Device: Electronic Horn.

- a. Mounting: Single-gang flush wall.

F. FA-211; Combination Audio Horn and Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. (W) Weatherproof Audio/Visual Notification Device: Electronic horn with high intensity strobe, square housing, 75 Candela, suitable for wet locations. Provide with weatherproof back box.
  - a. Mounting: Semi-flush wall.
  - b. Conduit shall not be exposed.

G. FA-230; Emergency Combination Audio (Voice) and Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. Combine speaker and visual components shall have a clear lens for fire alarm annunciation strobe and an amber lens for the alert strobe into a single device. Refer to the corresponding paragraphs above for requirements of each component.

H. FA-232; Emergency Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. High intensity xenon strobe or equivalent shall have a clear lens for fire alarm annunciation strobe and an amber lens for the alert strobe. Candela rating shall be visible from exterior of the device.
3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

## 2.10 DOOR HOLD-OPEN DEVICES

A. FA-270; Electromagnetic Door Holder Devices:

1. Flush wall mounted.
2. Voltage: 24VAC.
3. Holding force shall be 25 pounds minimum.
4. Provide fail-safe operation; power failure releases door.
5. Provide self-adjusting swivel catch plate with pivot points to adjust to door alignment changes.
6. Provide all hardware and wiring needed to accommodate the complete functioning door holder installation.
7. Ensure that the door hardware and trim projections are compatible with total projection of door release.
8. Follow manufacturer's recommended installation and location instructions unless noted otherwise.

## 2.11 ELEVATOR SHAFT DAMPER CONTROL

- A. FA-253: If the fire alarm remote annunciator cannot accommodate the pushbutton, provide a 10A, 120V switch in a separate lockable recessed enclosure finished to match the fire alarm annunciator panel directly adjacent to the annunciator directly adjacent to the panel in elevator lobby on fire attack level. The enclosure shall be keyed identically to the remote annunciator.

- B. FA-253: Hoistway damper switch for manual control of elevator shaft damper. 2-position selector switch for open/close control, maintained operator, NEMA ICS 5-1 contact block. Provide normally open contact for fire alarm interface. Nameplate shall identify associated elevator and open/close damper position. Surface Flush mount enclosure provided by fire alarm vendor to match control panel.

1. Manufacturers:
  - a. Allen Bradley 800T-H2A
  - b. Square D

## 2.12 NOTIFICATION APPLIANCE CIRCUIT PANEL (NAC)

- A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NAC on the shop drawing submittals.
- B. Each NAC shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NAC provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.
- C. Power for each NAC shall be from a local 120 VAC emergency circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NAC from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with the Architect/Engineer prior to installation.
- D. NAC extender panels may be installed only where shown on drawings in locations coordinated with the Architect/Engineer.
- E. Mounting: Flush Surface.

## 2.13 ANNUNCIATION

- A. CGA; Color Graphics Network Annunciation System:
  1. The annunciator shall provide custom color graphics displays for the control panel to annunciate the status of the panel and every peripheral device. It shall record and display system historical information on an LCD flat panel display.
  2. The annunciator shall have the ability to display a minimum of 256 custom screens and shall be fully field programmable. The fire alarm vendor shall develop screens from DXF or DWGCAD files provided by the Owner.
  3. Operator control shall be via an attached keyboard and mouse.
  4. The annunciator shall store all alarms, troubles and operator activity to an internal hard drive and shall have a capacity of 10,000 events without data loss.
  5. Events shall have a time and date stamp.
  6. Graphics shall contain eight (8) different colors from a palette of sixty-four (64).
  7. Graphics software shall be provided to display on single or multiple screens, the status of every device located on a floor plan of the building. Alarms shall be audio and visual and shall annunciate regardless of the screen that is currently visible. Text on screens shall be a minimum of 1/10" high. Coordinate with the Owner, the floor plan on each screen prior to programming.

8. Provide TROUBLE ACKNOWLEDGE, DRILL, and ALARM SILENCE capability at the color graphics annunciation location.
  9. The systems shall operate on the most current UL 864 listed computer system. The system shall be supplied by the fire alarm vendor and be listed for fire alarm use.
  10. Provide an uninterruptible power supply (UPS) to provide a minimum of 10 minutes of operating power for the computer graphic annunciator upon loss of normal power.
  11. All equipment for the color graphics network annunciator shall be suitable for locating on a desk, provided by the Owner. When multiple workstations are required (multiple locations within a facility or multiple buildings on a campus), they shall be server/client based configuration.
  12. Remote Client Workstations: All workstations shall have the same user functionality. User shall have the ability to take over network control functionality from any station as follows:
    - a. Request to take control
    - b. Accept/deny control request
    - c. Restore command center to normal operation
    - d. Priority request override
  13. PC computer workstation shall have the following minimum operating system requirements:
    - a. Operating system shall be a minimum of Microsoft Windows 7.
    - b. 3.0 GHz processor (server workstation)
    - c. 128 GB RAM installed (server workstation)
    - d. i7 Intel processor (client workstation)
    - e. 32 GB RAM installed (client workstation)
    - f. 500 GB hard drive
    - g. 22-inch LCD monitor minimum
- B. Printer:
1. Printer shall be UL 864 listed and shall be the automatic type with code, time, date, location, category and condition.
  2. The printer shall provide hard copy printout of all changes in status of the system and shall time-stamp such printouts with the current time of day and date. The printer shall be standard carriage with 80 characters per line and shall use standard bond paper. The printer shall be enclosed in a separate enclosure, suitable for placement on desk or countertop. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association Standard EIA-232D. Power to the printer shall be 120 VAC, 60 Hertz.
  3. The printer shall be connected to the graphics annunciator PC and shall have all interfaces in place to be connected to the Fire Command Center and all transponders in case of network or hardware failure.
- C. FAA; Remote LCD Annunciators:
1. Auxiliary annunciators shall indicate alarm and trouble conditions visually and audibly as shown on the drawings. Provide local TROUBLE ACKNOWLEDGE, TEST, and ALARM SILENCE capability. Minimum 80-character display.
  2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
  3. A single key switch shall enable all switches on the annunciator.
  4. Mounting: Flush Surface.

- D. Facility Management Control System (FMCS) Interface:
1. Provide addressable relays to report the following to the FMCS via dry contact monitoring on the FMCS:
    - a. General Alarm
    - b. System Trouble
    - c. Supervisory Alarm
    - d. Other Alarms (if applicable)
  2. Provide BACnet IP interface for fire alarm panel to communicate status with the FMCS. Provide list of points and descriptions to FMCS supplier.
    - a. UL listed to Standard 864. Provide RJ45 connection and cable.
- E. FA-241; Fire Alarm Remote Indicator:
1. Red LED type.
  2. Mounts flush to a single gang box.
- F. FA-242; Fire Alarm Remote Indicator and Test Switch:
1. Key switch test selector.
  2. Mounts flush to a single gang box.

## 2.14 ETHERNET NETWORK

- A. Campus Ethernet IP Network: A complete fire alarm and mass notification Ethernet network shall be provided. The network shall be Class X wiring, Resilient Ethernet Protocol (REP) 100BaseTX / 100 Mbps that shall be able to operate with any single break and restore network communications.
- B. The IP network shall be fiber optic cable, single or multi-mode fiber. The TCP/IP network switches shall be industrial grade managed switching hubs. Network switches shall be UL864 listed, shall provide a minimum of four (4) or a maximum of eight (8) 10/100 Mbps shielded RJ-45 connectors for Ethernet connections, and selectable multi-mode or single-mode fiber ports. The switches shall operate on a nominal 24 VDC supplied from a battery backed up fire alarm control panel or booster power supply to ensure power to the switch is always available. Switches shall provide LED indicators for data rate, activity/link integrity, power, and loop detection.
- C. IP Monitor and Relay Module: The IP relay/input module shall have a minimum of four (4) dry contact inputs and four (4) dry contact outputs. The relay output shall be rated at 0.5 amps at 24 VDC. This unit shall be monitored and controlled by the graphics workstation to operate functions and/or operations/activations on any fire alarm network system connected to the GEGW. The module shall be UL2572 and UL864 listed.
- D. Voice Over IP Module Encoder/Decoder: Each control panel audio source connected to the LAN/WAN network interface shall consist of a supervised audio decoder capable of decoding MP3, WMA, G.700, and PCM data streams in HTTP, UDP, or RTP format. Audio decoder shall operate on filtered-regulated 24 VDC power derived from the panel power supply. Power shall be supplied directly from the FACP to ensure reliable and monitored power. UL 2572 and UL864 listed.



## 2.15 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

### A. FA-250; Smoke and Fire/Smoke Damper Controller:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
2. Device types as follows:
  - a. + = Indicates equipment system associated with smoke or fire/smoke damper.
3. Motorized type 24 VAC, furnished and installed by MC. Fire alarm control and power connections by EC. A subscript is used to identify the device with a specific air handler or zone for its sequence of operation. Refer to the Fire Alarm Operation Matrix on the drawings and the sequence of operation descriptions in this specification section for additional requirements.
4. The EC provides:
  - a. Fire alarm control and power connections by EC.
  - b. Fire alarm addressable control module (FA-161) located within 5 feet of smoke damper.
  - c. Smoke detection, selected by NICET designer based on duct size, ventilation airflow, and specific field conditions. Detector shall be mounted within 5 feet of smoke damper. Approved options include:
    - 1) Smoke Detector (FA-120) (ID) In-Duct Detector. In-duct smoke detector in ducts less than 18". Detector shall be listed for use in HVAC ductwork.
    - 2) Duct Smoke Detector (FA-122). Sampling type duct detector (FA-122) in ducts 18" and larger.
  - d. Remote indicator (FA-241) or Remote Indicator with test switch (FA-242) mounted in visible location. Refer to drawings for mounting location or verify location with engineer when not shown.
  - e. The smoke damper shall close upon activation of the detector, and a supervisory signal shall be sent to the fire alarm control panel. Refer to the Fire Alarm Operation Matrix and these specifications for complete requirements.
5. Provide an enclosure and equipment for interface of dampers with the fire alarm system and temperature control system.

### B. FA-260; Flow Switch:

1. (FA-260) Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Provide a dedicated monitor switch for each sprinkler flow switch.

### C. FA-261; Tamper / Monitor Switch:

1. (FA-261) Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Tamper switches in the same room or system may be monitored by a single monitor switch when shown grouped on the plans.
3. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

4. Device types as follows:
    - a. Blank = Refer to Plans
    - b. PIV = Post Indicator Valve
  5. (PIV) Post Indicator Valve. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.
- D. FA-263; Electronic Bell:
1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.
- E. FA-271; Door Hold Device:
1. Subscript: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    - a. DH - Door Hold Open
    - b. PD = Hold Open Override
  2. (BLANK) Integral with door hardware, 24 VAC. Furnished and installed by GC. Fire alarm control and power connections by EC.
  3. (PD) Hold open override connection to GC-provided power door operator. EC shall intercept the hold open switch wiring (unless specific contacts for this purpose are provided on the door) and connect addressable relay to override this switch and allow the door to close. All modifications to the power door operator shall be coordinated with the GC.
- F. FA-161; Lighting Control Override:
1. Subscript: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    - a. LC = Lighting Control Override
  2. The lighting control system(s) is equipped with a remote input fire alarm override contact to allow the fire alarm system via an output relay to override the lighting control sequence of operation upon a fire alarm "alarm" condition. The fire alarm system will provide addressable fire alarm output relay(s) to interface with the lighting control system. Coordinate the location and quantity of relays required with the lighting control system.
  3. Provide (FA-161) fire alarm addressable control module for each interface required for the lighting control system.
- G. FA-160; Knox Box Monitor:
1. Subscript: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    - a. KB = Knox Box

2. Monitored Knox box furnished and installed by GC. Provide addressable monitor module (FA-160) for Knox box monitoring. Refer to architectural plans for requirements and location.

## **2.16 WIRING**

- A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.
- B. Fire Alarm Cable:
  1. Manufacturers:
    - a. Comtran Corp.
    - b. Helix/HiTemp Cables, Inc.
    - c. Rockbestos-Suprenant Cable Corp.
    - d. West Penn Wire/CDT.
    - e. Radix.

## **PART 3 - EXECUTION**

### **3.1 SEQUENCES OF FIRE ALARM OPERATION**

- A. General:
  1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
  2. The GUI/graphic annunciator shall display audible and visual alarms. The device activated shall be immediately displayed on a CAD floor plan at approximately 1/8" scale. Visual indication shall further indicate the device by utilizing an easily recognized color change of the symbol. The use of flashing symbols is encouraged.
  3. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
- B. Audible Alarms Sequence:
  1. Audible alarms throughout the building shall sound.
  2. Audible alarms within the floor or fire/smoke compartment where the emergency signal originated and in adjacent areas shall sound.
  3. Separate voice announcements shall be played in different fire compartments depending on proximity to the device that initiated the alarm. Refer to the requirements above for the Voice Command Center programming.
- C. Visual Alarms Sequence:
  1. Visual alarms throughout the building shall flash.
  2. Visual alarms within the floor or fire/smoke compartment where the emergency signal originated and in adjacent areas shall flash.

D. Fire Protection Electric Sprinkler Bell Sequence:

1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

E. Double Interlocked Preaction Sprinkler Activation Sequence:

1. The fire alarm system shall utilize an addressable relay to signal the double-interlock preaction sprinkler system to allow filling with water upon initiation of alarm in zone of sprinkler coverage.
2. Where there are multiple zones to the preaction system, a separate addressable relay shall be provided for each zone and the system shall be programmed to signal only the zone that is in the area of the fire. Coordinate with the fire protection system installer.
3. The fire alarm system shall utilize addressable monitor modules to monitor the control panel supervisory and trouble conditions.

F. Clean Agent Release Sequence:

1. The fire alarm system shall utilize an addressable relay to signal the clean agent release panel to activate upon initiation of alarm in two zones of detection.
2. Where there are multiple clean agent zones, a separate addressable relay shall be provided for each zone, and the system shall be programmed to signal only the zone that covers the area of the fire. Coordinate with the clean agent system installer.

G. Kitchen Hood Fire Suppression System Sequence:

1. The fire alarm system shall utilize an addressable relay to de-energize the hood supply fan controller.
2. The fire alarm system shall utilize an addressable monitor module to monitor the fire suppression system.

H. Smoke Damper Control Sequence:

1. The fire alarm system shall utilize an addressable relay to open the power connection to smoke or fire/smoke dampers and allow them to close. Coordinate other requirements with damper installer.
2. Where a damper is in a main air duct, where closure of that single damper will entirely block airflow in the duct system, the smoke damper sequence shall also initiate the AHU and mechanical fan shutdown sequence for the affected unit.
3. The AHU and mechanical fan shutdown sequence shall be initiated only when ALL the dampers associated with that unit or mechanical fan are closed. Otherwise, the AHU or mechanical fan shall continue to serve other areas.
4. Smoke and fire/smoke dampers located in branch ductwork shall be closed individually or in groups, as identified on the plans.
5. All smoke and fire/smoke dampers shall be closed throughout the building.

I. AHU and Mechanical Fan Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
3. All AHUs and mechanical fans shall be shutdown simultaneously throughout the building.

- J. Fire Door Release Sequence:
1. The fire alarm system shall utilize an addressable relay to signal the fire door or curtain to close. Once the alarm is cleared, the addressable relay shall allow the door to open.
  2. Where a facility has more than one fire door, each shall release individually based on input from initiation devices in the vicinity of each door and noted specifically for door closure.
- K. Power-Operated Fire Doors Sequence:
1. The fire alarm system shall utilize an addressable relay to signal or disconnect power to the power-operated fire door, allowing automatic closing and latching of the door. Once the alarm is cleared, the addressable relay shall allow the door to open.
  2. Door holders shall release individually based on initiation devices in the vicinity of the door and noted specifically for door closure.
  3. All door holders throughout the building shall release simultaneously.
- L. Door Holder Release Sequence:
1. The fire alarm system shall utilize an addressable relay to open the power connection to integral and magnetic door holders.
  2. The fire alarm system shall utilize an addressable relay to open the 'hold' switch circuitry, integral to the power door.
  3. All door holders throughout the building shall release simultaneously.
- M. Firefighter's Cab Visual Alarm Sequence:
1. Upon signal from a detector in the machine room or elevator hoistway, the fire alarm system shall utilize an addressable relay to signal the elevator controller to illuminate and flash the firefighters cab visual alarm.
- N. Access Control Override Sequence:
1. The fire alarm shall use addressable output relay(s) to signal the access control panel.
  2. Refer to the access control specifications for requirement upon fire alarm signal. The fire alarm shall initiate an override of delayed egress doors.

### **3.2 INSTALLATION**

- A. Install system in accordance with manufacturer's instructions and referenced codes.
- B. Fire Alarm Control Panel:
1. Install the control panel where shown on the drawings.
  2. All expansion compartments, if required, shall be located at the control panel.
  3. Install the voice command center and fire command center in the location as indicated on the drawings. This location should be primary fire department "attack" location. Coordinate with the local fire department prior to submitting shop drawings.
  4. The fire alarm voice prerecorded messages shall be verified by the Contractor, as approved by the Owner, prior to the shop drawing submittal process.

## C. Devices:

1. General:
  - a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
  - b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
  - c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.
  - d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.
2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
3. Protection of Fire Alarm System:
  - a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.
4. Analog Smoke and Heat Detectors:
  - a. In elevator shafts and elevator equipment rooms, provide a heat detector for elevator shutdown within 2' of every sprinkler head. Coordinate with fire protection contractor.
5. Duct-type Analog Smoke Detectors:
  - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
  - b. All detectors shall be accessible.
  - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
6. In-Duct Analog Smoke Detectors:
  - a. In-duct analog smoke detectors shall be installed in the duct where shown on the drawings and details. The devices shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
  - b. All detectors shall be accessible.

7. Heat Detector, Linear Wire Type:
    - a. Install detection wire within 20 inches of the underside of building roof, floor, or as recommended by the manufacturer.
    - b. The protected area shall not exceed 4,000 square feet per zone. Provide a separate zone for areas divided by fire/smoke rated walls.
  8. Manual Pull Stations:
    - a. Stations shall be located where shown and at the height noted on the drawings.
  9. Addressable Relays and Monitor Modules:
    - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
    - b. All modules shall be mounted in or on a junction box in an accessible location.
    - c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.
  10. SLC Loop Isolation Modules:
    - a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.
    - b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.
  11. Notification Appliance Devices:
    - a. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.
    - b. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.
- D. Wiring:
1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
  2. Refer to Identification Section 260513 for color and identification requirements.
  3. Wiring shall be installed in conduit from device to above accessible ceilings. Exposed plenum-rated cable (FPLP) shall be used above accessible ceilings supported every 4 feet or run in cable trays (if applicable) maintaining a minimum of 5-inches clearance from all lighting ballasts. Fire alarm cabling shall not be installed in the same bridge rings or cable trays designated for the cabling of other systems.
  4. All junction boxes with SLC and NAC circuits shall be identified on cover. Refer to Identification Section 260513 for color and identification requirements.
  5. Partial evacuation or relocation of occupants is the standard operating procedure for this facility in the event of an alarm. Therefore, all notification appliance circuits (NAC), including circuits serving NAC extender panels and other network communication circuits, must be installed and protected in accordance with the "circuit survivability" requirements described in NFPA 72. Contractor shall maintain the following:

- a. NACs serving separate evacuation signaling zones shall be routed separately such that they are no less than 4 feet apart when run horizontally and 1 foot apart when run vertically. They may come simultaneously only within 10 feet of the control panel. Evacuation signaling zones are identified on the drawings.
  - b. NACs passing through other evacuation signaling zone(s) shall be installed in conduit and routed through the 2-hour fire-rated chase(s) or enclosure(s) identified on the drawings.
  - c. NACs passing through other evacuation signaling zone(s) shall be Electrical Code classified CIC cable (Fire Alarm Circuit Integrity) installed in conduit. Provide CIC cable meeting UL requirements for 2-hour listing.
    - 1) The CIC cable system shall be installed in a conduit system meeting all requirements of its UL-listed installation system (conduit, boxes, connectors, etc.).
6. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 260513.
7. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
- a. Fire alarm temporal audible notification for all audio appliances.
  - b. Synchronization of all visual devices where two or more devices are visible from the same location.
  - c. Ability to silence audible alarm while maintaining visual device operation.
  - d. Emergency communication alert and textual visible appliance notification.
8. Notification Appliance Circuits shall not span floors or smoke compartments. Refer to architectural drawings for smoke compartments.
9. Signal line circuits connecting devices shall not span floors or 2-hour smoke compartments.
10. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
11. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.
- E. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
- 1. Power Branch Circuit Conductors: In accordance with Section 260553.
  - 2. Signaling Line Circuit: Overall red jacket with black and red conductors.
  - 3. DC Power Supply Circuit: Overall red jacket with violet and brown conductors.
  - 4. Notification Appliance Circuit: Overall red jacket with blue and white conductors.
  - 5. Door Release Circuit: Gray conductors.
  - 6. Central Station Trip Circuit: Orange conductors.
  - 7. Central Station Fire Alarm Loop: Black and white conductors.
- F. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.



- G. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

### 3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 260500.
- B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
- C. Contractor shall test and adjust the fire alarm system as follows:
  - 1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
    - a. 70dBA.
    - b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
    - c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
    - d. As specified on the drawings.
  - 2. Sound level measurement procedure shall meet the following requirements:
    - a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
    - b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
    - c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
    - d. Final ambient sound measurements shall be taken during occupancy and the units shall be re-adjusted at that time, if necessary.
    - e. All sound level measurements shall be taken at a height of 5' above the finished floor level.
    - f. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of two (2) rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
    - g. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
    - h. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.
- D. Additionally, test the voice alarm communication system intelligibility per IEC 60849:
  - 1. The following acoustically distinguishable spaces shall be tested: All unique rooms shall be tested.
  - 2. Utilize equipment designed to test per IEC 60849 per the equipment manufacturer's instructions. This equipment includes a signal generator, which is input to the fire alarm system and a portable measurement device. This equipment is available from Simplex Grinnell or Gold Line.
  - 3. Testing equipment that can simulate 'crowd babble' shall be used in rooms with occupancy of greater than 200.

4. Wide-area notification intelligibility shall be tested in acoustically distinguishable spaces and areas as designated by the Owner.
5. When testing for intelligibility, the quantity and location of the measurement points shall be the same as the points used for measurement of dBA level.
6. Provide a room by room report, showing the average dBA level and STI for each room tested, the number and location of. The report shall be presented to the Architect/Engineer in an Excel .xls file.

### **3.4 MANUFACTURER'S FIELD SERVICES**

- A. Provide manufacturer's field services under provisions of Section 260500.
- B. Include services of the manufacturer's software programmer to write initial custom-user program (for Color Graphics Annunciation System).
- C. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- D. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.
- E. Include the services to train up to three of the Owner's staff in operation, maintenance, and programming of the fire alarm system at the manufacturer's factory. Airfare and lodging expenses for the Owner's staff will be by the Owner.
- F. System Occupancy Adjustments: When requested by Owner within 12 months of date of Substantial Completion, provide on-site system adjustments to suit actual occupied conditions. For this purpose, provide up to two (2) site visits, four (4) hours each visit, outside normal occupancy hours.

### **3.5 SYSTEM TRAINING**

- A. System training shall be performed under provisions of Section 260500.
- B. Minimum on-site training times shall be:
  1. System Operators: One (1) day.
  2. GUI Operation and Editing: One (1) day.
  3. Emergency Communication System: Four (4) hours.

END OF SECTION 283101

## **SECTION 31 10 00 - EARTHWORK**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes:
1. Excavation, filling, and backfilling for structures, pavement, and site areas
  2. Trenching and backfilling for utilities.
  3. Dewatering.
- B. Related Sections
1. Section 02 22 00 - Site Demolition
  2. Section 31 20 00 - Rock Excavation
  3. Section 31 30 00 - Soil Stabilization
  4. Section 31 40 00 - Erosion Control and Sedimentation. Temporary and permanent erosion control.
- C. **Order of Precedence: The “Geotechnical Engineering Report” as prepared by Terracon Conulstants, Inc. (dated July 20, 2022, project Number 02225131) specifies requirements for earthwork preparation and placement of fill and his herein incorporated by reference. The “Geotechnical Engineering Report” provisions shall take precedence over the provisions of this section whenever duplication or conflict occurs.**

#### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. ASTM D 422 - Standard Test Method For Particle Size Analysis of Soil
  2. ASTM D 698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN.m/m<sup>3</sup>))
  3. ASTM D 1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 Kn.m/m<sup>3</sup>))
  4. ASTM D 2922 - Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)
  5. ASTM D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils
  6. ASTM D 5268 – Standard Specification for Topsoil used for Landscaping purposes.
- B. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO T 88 - Particle Size Analysis of Soils
- C. State Department of Transportation (DOT):
1. "Standard Specifications for State Road and Bridge Construction", Kansas Department of Transportation, including all revisions.
- D. National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code
- E. American Water Works Association (AWWA)
1. AWWA C200 - Standard For Steel Water Pipe - 6 In. (150 Mm) And Larger
  2. AWWA C206 - Field Welding Of Steel Water Pipe

#### 1.3 QUALITY ASSURANCE

- A. An independent testing laboratory (ITL) (selected and paid for by the Owner, unless otherwise stipulated in the contract documents), will be retained to perform construction testing on site.
1. The independent testing laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, Civil Engineering Consultant, and General Contractor shall be

provided with copies of reports within 96 hours of time that test was performed. In event that test performed fails to meet Specifications, the independent testing laboratory shall notify Owner and Contractor immediately.

2. Costs related to retesting due to failures shall be paid for by the Contractor at no additional expense to Owner. Contractor shall provide free access to site for testing activities.
3. Quality assurance testing will be conducted in accordance with Paragraph "Field Testing" in Part 3 hereinafter.

B. Analysis of Samples and Test:

1. Engineer reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request.
2. Remove rejected materials immediately from the site at Contractor's expense. Cost of testing of materials not meeting specifications shall be paid by the Contractor.

1.4 DEFINITIONS

- A. Satisfactory Soils: ASTM D 2487 soil classification groups CL, GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than allowed for fill or backfill material as specified hereinafter or as shown on the drawings. Satisfactory soil shall contain no debris, waste, frozen materials, vegetation, and other deleterious matter.
- B. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory including materials classified in ASTM D 2487 soil classification groups GC, SC, ML, MH, CH, OL, OH, and PT, or a combination of these group symbols.
  1. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Owner shall be notified of any contaminated materials.
  2. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- C. Rock: Rock shall be as defined in Section 31 20 00.

1.5 SUBMITTALS

- A. Submit 30-pound sample of each type of off-site fill material that is to be used at the site in airtight containers to the independent testing laboratory or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review.
- B. Submit certification that all material obtained from off-site sources complies with specification requirements.
- C. Submit name of each material supplier and specific type and source of each material. Change in source throughout project requires approval of Owner.
- D. If fabrics or geogrids are to be used, design shall be submitted for approval to Owner in accordance with Section 31 30 00.
- E. Submit Dewatering Plans upon request by Owner.
- F. Shop drawings or details pertaining to excavating and filling are not required unless otherwise shown on the Drawings or if contrary procedures to Construction Documents are proposed.
- G. Shop drawings or details pertaining to site utilities are not required unless required by regulatory authorities or unless uses of materials, methods, equipment, or procedures that are contrary to The Drawings or Specifications are proposed. Do not perform work until Owner has accepted required shop drawings.

**PART 2 - PRODUCTS****2.1 SOIL AND ROCK MATERIALS**

- A. Fill and Backfill. Satisfactory soil materials excavated from the site.
- B. Imported Fill Material: Satisfactory borrow material provided from offsite borrow areas when sufficient satisfactory soil materials are not available from required excavations.
- C. Trench Backfill: ASTM D 2321 unless otherwise specified or shown on the drawings.
- D. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Bedding: Aggregate Type as indicated on the plans or naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- I. Topsoil:
  - 1. Topsoil shall consist of stripping material excavated from the site. If inadequate topsoil is not available on site, the Contractor shall provide topsoil from other available sources. If necessary, Engineer shall approve source of additional topsoil prior to purchase, delivery and installation.
  - 2. Topsoil shall consist of organic surficial soil found in depth of not more than 18-inches. Topsoil shall be natural, friable, fertile, fine loamy soil possessing characteristics of representative topsoil in the vicinity that produces heavy growth, free from subsoil, objectionable weeds, litter, sods, stiff clay, stones larger than 1-inch in diameter, stumps, roots, trash, toxic substances, or any other material which may be harmful to plant growth or hinder planting operations. Topsoil shall be black, friable material. The soil shall be taken from the "A" horizon or upper layer of local undisturbed soil that produces heavy vegetative growth.

Acidity/Alkalinity: pH 6.0 to pH 7.0

Grading Analysis: Two-inch (2") sieve, 100% minimum passing. Number 4 sieve, 90% minimum passing. Number 10 sieve, 80% minimum passing.

Sand, Silt and Clay Content (ASSHTO M146)

Sand: 20 to 75 percent

Silt: 10 to 60 percent

Clay: 5 to 30 percent

All Topsoil shall be free from all herbicides and insecticides that might adversely affect subsequent growth of turf or plantings or that might otherwise contain materials toxic to humans and pets.

- J. Stabilization fabrics and geogrids: As specified in Section 31 30 00.
- K. Filter and drainage fabrics: As specified in Section 31 40 00.
- L. Trench Utility Locator Tape: Heavy duty 6" wide underground warning tape. Tape shall be made from polyethylene material, 3.5 mils thick, with a minimum tensile strength of 1,750 psi. Place the tape at one-half the minimum depth of cover for the utility line or a maximum of 3 feet, which ever is the less, but never above the top of subgrade. Color of tape shall be determined by as follows:
  1. Natural Gas or Propane - Yellow
  2. Electric - Red
  3. Telephone – Orange
  4. Water – Blue
  5. Sanitary Sewer – Green

## 2.2 EQUIPMENT

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping. Transported material must be covered during off-site transport.

## 2.3 SOURCE QUALITY CONTROL

- A. Laboratory testing of materials proposed for use in the project shall be by the Owner's Independent Testing Laboratory (ITL) at no cost to Contractor. The Contractor shall provide samples of material obtained off-site.
- B. In areas to receive pavement, California Bearing Ratio (CBR) or Limerock Bearing Ratio (LBR) tests shall be performed for each type of material that is imported from off-site. CBR or LBR value shall be equal to or above pavement design subgrade CBR or LBR value as stated in the Geotechnical Engineering Report or as indicated on Construction Drawings.
- C. Following tests shall be performed on each type of on-site or imported soil material used as compacted fill:
  1. Moisture and Density Relationship: ASTM D 698 or ASTM D 1557.
  2. Mechanical Analysis: AASHTO T 88 or ASTM D422.
  3. Plasticity Index: ASTM D 4318

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Identify required lines, levels, contours, datum, elevations, and grades necessary for construction as shown on the drawings.
- B. Notify and coordinate with utility companies to remove or relocate public utilities that are in conflict with proposed improvements.
- C. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs, unless otherwise noted on the drawings from excavating equipment and vehicular traffic.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
- E. Remove from site, material encountered in grading operations that, in opinion of Owner or the Owner's Independent Testing Laboratory (ITL) is unsuitable or undesirable for backfilling, subgrade, or

foundation purposes. Dispose of in manner satisfactory to Owner. Backfill areas with layers of suitable material and compact as specified herein.

- F. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform following procedures:
  1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain the same results.
  2. After drainage of low area is complete, remove muck, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed.
  3. All muck, mud, and other materials removed from low areas shall be dried on-site by spreading in thin layers for observation by the ITL. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under building subgrade or within 5'-0" of perimeter of building subgrade or paving subgrade. If, after observation by the ITL, material is found to be unsuitable, unsuitable material shall be removed from site.
- G. Locate and identify utilities that have previously been installed and protect from damage.
- H. Locate and identify existing utilities that are to remain and protect from damage.
- I. Maintain in operating condition existing utilities, previously installed utilities, and drainage systems encountered in utility installation. Repair surface or subsurface improvements shown on The Drawings.
- J. Verify location, size, elevation, and other pertinent data required making connections to existing utilities and drainage systems as indicated on The Drawings.
- K. Over excavate and properly prepare areas of subgrade that are not capable of supporting proposed buildings or pavements. Stabilize these areas by using acceptable geotextile fabrics, flyash stabilization techniques or aggregate material placed and compacted as specified in Section 31 30 00.
- L. The Contractor shall be responsible for designing the excavation slopes and/or temporary shoring and bracing. All excavations (slope height, slope inclination, excavation depths, etc.) shall meet the requirements specified in federal, state, and/or local safety regulations (e.g. the latest version of OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926), The Contractor shall perform periodic inspections of all excavations to check for stability. Tension cracking, sloughing of the soils, unusually soft soil zones, or the bulging of soil at the toe of the slope indicate stability problems which shall be immediately investigated, addressed, and corrected by the Contractor. The Contractor shall be responsible for the training and safety of all individuals entering excavations.
- M. All areas that will be developed on-site shall be stripped of any topsoil, vegetation, large rock fragments (greater than 6 inches in any dimension), existing unsuitable fill that may have been placed on the site, and any other deleterious materials. The actual stripping depth shall be based on visual examination by the Owner's ITL during grading operations and and the results of the proof-rolling operation. Stripped soils may be used as general fill outside building and pavement area limits. Stockpile suitable topsoil separately from general excavation spoils for later use.

### 3.2 DEWATERING

- A. General:
  1. Provide dewatering systems as required for excavations.
  2. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a "quick" or "boiling" condition. System shall not be dependent solely upon sumps or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation's stability.

3. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow Work to be installed in a dry condition.
4. Control, by acceptable means, all water regardless of source. Contractor shall be responsible for disposal of the water.
5. Confine discharge piping or ditches to available easement or to additional easement obtained by Contractor. Provide necessary permits or easement.
6. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary, lower water level in advance of excavation utilizing wells, wellpoints, jet educators, or similar positive methods. The water level as measured by piezometers shall be maintained a minimum of 3 feet below prevailing excavation level.
7. Commence dewatering prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
8. Open pumping with sumps and ditches will be allowed provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
9. Install wells or wellpoints, if required, with suitable screens and filters so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner. During normal pumping and upon development of wells, levels of fine sand or silt in the discharge water shall not exceed 5 ppm. Install sand tester on discharge of each pump during testing to verify that levels are not exceeded.
10. Control grading around excavations to prevent surface water from flowing into excavation areas.
11. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head.

B. Design:

1. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
2. Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.
3. Contractor shall be responsible for the design, installation, operation, maintenance, and any failure of any component of the system.

C. Damages:

1. Contractor shall be responsible for and shall repair any damage to work in place, other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation. Contractor responsibility shall also include, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.
2. Remove subgrade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the Owner.

D. Maintaining Excavation in Dewatering Condition:

1. Dewatering shall be a continuous operation. Interruptions due to power outages, or any other reason will not be permitted.
2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.
3. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner.



4. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain excavation in dewatered condition.
- E. System Removal: Upon completion of the work, remove dewatering equipment from the site, including related temporary electrical service.
- F. Wells shall be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction.

### 3.3 TOPSOIL EXCAVATION

- A. Cut heavy growths of grass from areas before stripping and remove cuttings with remainder of cleared vegetative material.
- B. Strip topsoil from areas that are to be filled, excavated, landscaped, or re-graded to such depth that it prevents intermingling with underlying subsoil or questionable material.
- C. Stockpile topsoil in storage piles in areas shown on The Drawings or where directed by Owner. Construct storage piles to freely drain surface water. Cover storage piles as required to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by Owner. Remove excess topsoil from site unless specifically noted otherwise on The Drawings or otherwise specified by the Owner.

### 3.4 GENERAL EXCAVATION

- A. Classification of Excavation: The Contractor shall assure himself by site investigation or other necessary means that he is familiar with the type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation, except as may be indicated in the Contract Documents.
- B. When performing grading operations during periods of wet weather, provide adequate dewatering, drainage and ground water management to control moisture of soils.
- C. Shore, brace, and drain excavations as necessary to maintain excavation as safe, secure, and free of water at all times.
- D. Excavate building areas to line and grade as shown on the Drawings being careful not to over excavate beyond elevations needed for building subgrades.
- E. Place suitable excavated material into project fill areas.
- F. Unsuitable excavated material shall be disposed of in manner and location that is acceptable to Owner and local governing agencies.
- G. Perform excavation using capable, well-maintained equipment and methods acceptable to Owner and local governing agencies.

### 3.5 ROCK EXCAVATION

- A. Rock excavation is specified in Section 31 20 00.

### 3.6 TRENCHING EXCAVATION FOR UTILITIES

- A. Contact local utility companies before excavation begins. Dig trench at proper width and depth for laying pipe, conduit, or cable. Cut trench banks vertical, if possible, and remove stones from bottom of trench as necessary to avoid point-bearing. Over excavate wet or unstable soil, if encountered, from

trench bottom as necessary to provide suitable base for continuous and uniform bedding. Replace overexcavation with suitable and dispose of unsuitable material.

- B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
- C. Perform trench excavation as indicated on the Drawings for specified depths. During excavation, stockpile materials suitable for backfilling in orderly manner far enough from bank of trench to avoid overloading, slides, or cave-ins.
- D. Remove excavated materials not required or not suitable for backfill or embankments and waste off-site or at on-site locations approved by the Owner and in accordance with governing regulations. Dispose of structures discovered during excavation as specified in Section 02 22 00.
- E. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches and other excavations as specified.
- F. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel-type trenching machines are used, do not use clods for backfill.
- G. Accurately grade trench bottom to provide uniform bearing and support for each section of pipe on bedding material at every point along entire length except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make joint connection properly.
- H. For pipes 12 inches in diameter or smaller, total trench width below top of pipe shall be the outside diameter of the pipe plus not be less than 12 inches nor more than 18 inches with the pipe or conduit that is to be installed to designated elevations and grades, and centered in the trench. For pipe diameters greater than 12 inches, trench width below the top of pipe shall be wide enough to accommodate workmen and equipment but not less than 18 inches. Other trench width for pipe, conduit, or cable shall be least practical width that will allow for proper compaction of trench backfill.
- I. Trench depth requirements measured from finished grade or paved surface shall meet the following requirements or applicable codes and ordinances, whichever is more stringent:
  1. Water Mains: 42 inches to top of pipe barrel (minimum) or 6 inches below frost line, established by local building official, whichever is deeper.
  2. Sanitary Sewer: Elevations and grades as indicated on the Drawings.
  3. Storm Sewer: Elevations and grades as indicated on the Drawings.
  4. Electrical Conduits: 24 inches minimum to top of conduit or as required by NEC 300-5, NEC 710-36 codes, or local utility company requirements, whichever is deeper.
  5. TV Conduits: 18 inches minimum to top of conduit or as required by local utility company, whichever is deeper.
  6. Telephone Conduits: 18 inches minimum to top of conduit, or as required by local utility company, whichever is deeper.
  7. Gas Mains and Service: 30 inches minimum to top of pipe, or as required by local utility company, whichever is deeper.

### 3.7 SUBGRADE PREPARATION

- A. Scarification and Compaction: Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of 12 inches and compacted as specified hereinafter.

- B. Proofrolling: Subgrades shall be proofrolled to detect areas of insufficient compaction. Proofrolling shall be accomplished by making minimum of 2 complete passes with fully-loaded tandem-axle dump truck with an axial load greater than 9 tons, or approved equal, in each of 2 perpendicular directions while under the supervision and direction of the Owner's Independent Testing Laboratory. Document and explain proofrolling inspection procedures and results in the laboratory inspection report. Soils that are observed to rut or deflect excessively (typically greater than one inch) under the moving load are considered failure areas. Areas of failure shall be overexcavated, replaced with properly compacted low plasticity fill material, and recompacted as specified herein. Continual failure areas shall be stabilized in accordance with Section 31 30 00 at no additional cost to Owner. Subgrade exposed longer than 48 hours or on which precipitation has occurred shall be re-proofrolled.

### 3.8 FILLING

- A. Fill areas to contours and elevations shown on the Drawings with unfrozen materials.
- B. Place fills in continuous lifts specified herein.
- C. Fill within proposed building subgrade and paving subgrade shall not contain rock or stone greater than 6 inches in any dimension.
- D. Unless otherwise specified for rock fill, rock or stone less than 6-inches in largest dimension may be used in fill below structures, paving, and graded areas, up to 24 inches below surface of proposed subgrade or finish grade of graded areas when mixed with suitable material. Rock or stone less than 2 inches in largest dimension may be used in fill within the upper 24 inches of proposed subgrade or finish grade of graded areas when mixed with suitable material.
- E. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 8 inches loose measure and compacted as specified hereinafter.
- F. Building area subgrade pad shall be that portion of site directly beneath and five (5) feet beyond building and appurtenances as shown on the Drawings.
- G. Unless specifically stated otherwise in "Geotechnical Engineering Report", the following stipulates requirements of suitable materials to be used as fill in specified areas:

**Building area (upper 24 inches of building subgrade)** shall consist of Low Volume Change (LVC) material defined as approved, compacted granular fill or low to moderate plasticity cohesive soil materials consisting of inorganic silt or clay with a liquid limit less than 45 percent and a maximum plasticity index of 23 percent. Granular fill shall consist of compacted granular materials with a maximum particle size of two (2) inches or less, such as limestone screenings, moisture controlled KDOT AB-3 or other granular soil. Cohesive soils used as LVC materials may also consist of onsite clays stabilized with Class "C" flyash. Flyash contents shall be between 12 to 16 percent on a dry weight basis. The ITL shall determine the final percentage ratio as needed to obtain the desired reduction of shrink-swell potential.

**Pavement areas (upper 12 inches of pavement subgrade)** shall consist of on-site (as available) low to moderate plasticity cohesive soil materials consisting of inorganic silt or clay with a liquid limit less than 45 percent and a maximum plasticity index of 25 percent. On site soils not meeting this requirement may still be used by treating with Class "C" flyash or lime to reduce the plasticity index (to meet above limits), improve workability, promote drying and reduce shrink/swell potential. The ITL shall determine the final percentage ratio as needed to obtain the desired reduction of shrink-swell potential by conducting a laboratory class "C" flyash or lime series test.

### 3.9 ROCK FILL

- A. Rock fill shall include on-site excavated material classified as rock excavation as specified in Section 31 20 00. Rock fill may be utilized in fill up to 48 inches below top of subgrade or finish grade of graded

areas unless otherwise permitted in higher elevations by the ITL. Rock fill shall consist of rock having a maximum dimension not greater than 6 inches in any dimension. Rock fill shall be placed in successive horizontal layers of loose material having a thickness of approximately the maximum size of the larger rock in the lift, but not greater than 6 inches. Each layer of material shall be spread uniformly, completely saturated, and compacted. Shot rock shall not be dumped into place, but shall be distributed in horizontal lifts by blading and dozing in such a manner as to ensure proper placement into final position in the embankment. Voids shall be filled with finer material including shot rock fines and limited soil fines during the spreading operation. Successive layers shall not be placed until all voids of the current lift are filled and the lift is compacted. Each successive layer of material shall adequately bond to the material on which it is placed. Compaction shall be accomplished with vibratory compactors, heavy rubber-tired rollers, or steel-wheeled rollers. Compaction shall be by uniform passes of compaction equipment in sufficient number of passes, but not less than two passes, such that no further consolidation is evident as determined by the ITL.

B. BUILDING SUBBASE

C. Refer to Structural Drawings for required granular sub base below building concrete floor slabs.

3.10 PIPE BEDDING

A. Unless otherwise specified on the Construction Drawings, excavate trenches for pipe or conduit to 4 inches below bottom of pipe and to the width as specified herein. Place 4 inches of bedding material, compact in bottom of trench, and shape to conform to lower portion of pipe barrel.

3.11 TRENCH BACKFILLING

A. Unless otherwise specified on the Construction Drawings, materials used for trench backfill shall comply with requirements as specified herein.

B. Backfill and compact in accordance with fill and compaction requirements in accordance with ASTM D 2321 unless otherwise shown on the drawings.

C. Do not backfill trenches until required tests are performed and utility systems comply with and are accepted by applicable governing authorities.

D. Backfill trenches to contours and elevations shown on the Drawings.

E. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces. Remove unsuitable soils in accordance with specifications.

3.12 COMPACTION

A. Unless otherwise specified in the Geotechnical Engineering Report or by the ITL, compact as follows:

<u>Location</u>	Percent of Maximum Laboratory Density	
	<u>ASTM D698</u>	<u>ASTM D1557</u>
Subgrade & Fill Below Structures	98	95
Subgrade & Fill in Pavement and all other Areas	95	92

C. Fill materials shall be placed and compacted in lifts of 8-inches or less in loose thickness and each lift compacted per the above requirements.

D. Maintain moisture content of 0 to 4% above optimum for clay materials and of -2% to +2% of optimum for granular materials (or workable moisture contents as determined by the ITL).

E. Fill materials should not be frozen when placed or placed on frozen surfaces.

- F. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.
- G. Corrective Measures for Non-Complying Compaction: Remove and recompact deficient areas until proper compaction is obtained. Continual failure areas shall be stabilized in accordance with Section 31 30 00 at no additional cost to Owner.

### 3.13 MAINTENANCE OF SUBGRADE

- A. Verify finished subgrades to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material with CBR or LBR equal to or better than that specified in the Geotechnical Engineering Report. Surface of subgrade after compaction shall be firm, uniform, smooth, stable, and true to grade and cross-section.
- D. Construct temporary ditches and perform such grading as necessary to maintain positive drainage away from subgrade at all times.

### 3.14 BORROW AND SPOIL SITES

- A. Comply with NPDES and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil or borrow operations, clean up spoil or borrow areas in a neat and reasonable manner to the satisfaction of Owner or off-site property owner, if applicable.

### 3.15 FINISH GRADING

- A. Examination
  1. Prior to any seeding, sodding or landscaping, Contractor shall examine areas to be re-vegetated for compliance with requirements of these specifications and other conditions affecting performance.
  2. Verify that no foreign or deleterious material or liquids such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinners, turpentine, tar, roofing compound, lumber, or acid has been deposited in finish grade area that is to be planted.
  3. If contamination by foreign or deleterious material or liquid is present in soil within planting area, remove the soil and contamination and replace with new topsoil.
- B. Check grading of building subgrades by string line from grade stakes (blue tops) set at not more than 50-foot centers. Allowable tolerance shall be plus or minus 0.10 feet from plan grade. Provide engineering and field staking as necessary for verification of lines, grades, and elevations.
- C. Grade areas where finish grade elevations or contours are indicated on the Drawings, other than paved areas and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Ground surfaces shall vary uniformly between indicated elevations. Berms and ditches and other grade break areas shall be rounded and smooth. Do not leave pointed or sharp crested grading such that after grass is established would cause scalping, bare spots or difficulty in maintaining the planted area. Grade finished ditches to allow for proper drainage without ponding and in manner that will minimize erosion potential.
- D. Correct settled and eroded areas within 1 year after date of completion at no additional expense to Owner. Bring grades to proper elevation.

**3.16 TOPSOIL PLACEMENT FOR SOD AND SEED AREAS:**

- A. Prepare existing subgrade for placement of the topsoil by per the above requirements. Scarify the subgrade.
- B. The topsoil in the areas to be sodded or seeded shall be a minimum of 4" thick, except in areas where existing trees are to be preserved.
- C. Spread 4" of stockpiled pulverized loam topsoil, in a dry, loose condition, fertile, well drained and of uniform quality over scarified subgrade in all sod areas. Soil placement shall extend to the limits of construction disturbance associated with this project.
- D. Do not place topsoil if frozen or saturated.
- E. Contractor shall smooth the surface of the topsoil by harrow and/or box blade, or other suitable means. After placing topsoil and smoothing, any clodes that have formed over 3" in size shall be removed prior to sodding or seeding.
- F. The finished grade of the topsoil shall be smooth and uniform, void of any ruts or irregular grade breaks that would be difficult for a mowable surface.

**3.17 FIELD TESTING**

- A. Field density tests for in-place materials will be performed by the Owner's Independent Testing Laboratory (ITL) as follows:
  - 1. Building Subgrade Areas, Including 5'-0" Outside of Exterior Building Lines: In cut areas, not less than 1 compaction test for every 2,500 sq. ft. In fill areas, same rate of testing for each 8-inch lift, measured loose.
  - 2. Areas of Construction Exclusive of Building Subgrade Areas: In cut areas, not less than 1 compaction test for every 10,000 sq. ft. In fill areas, same rate of testing for each 8-inch lift, measured loose.
  - 3. Utility Trench Backfill: Intervals not exceeding 100-feet of trench for first and every other 8-inch lift of compacted trench backfill.
  - 4. Test Method: In-place nuclear density, ASTM D 2922 (Method B-Direct Transmission).
- B. Corrective Measures For Non-Complying Compaction: Remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner. Adjust moisture content as necessary to conform to the requirements of this section.
- C. Field testing, frequency, and methods may vary as determined by and between the Owner and the ITL.

**END OF SECTION 31 10 00**

## **SECTION 31 20 00 ROCK EXCAVATION**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

##### A. Section Includes

1. Removal of rock excavation.

##### B. Related Sections

1. Section 022300 – Site Clearing. Clearing of trees, brush, and vegetation prior to excavation.
2. Section 311000 – Earthwork: Excavation, filling, and compaction of earth materials and rock fill.

#### 1.2 REFERENCES

##### A. National Fire Protection Association (NFPA)

1. NFPA495 - Code for Manufacturing, Transportation, Storage, And Use of Explosive Material

##### B. United States Department of Interior, Bureau of Mines

1. Seismic Effects of Blasting

##### C. Occupational Safety & Health Administration (OSHA)

1. 29CFR1910.109 - Explosives and Blasting Agents

#### 1.3 DEFINITIONS

- ##### A. Rock Excavation: Removal of igneous, metamorphic, or sedimentary rock or stone, boulders over two cubic yards in volume in open areas and one cubic yard in volume in trenches; and masonry, concrete, or solid frozen soil that cannot be removed by rippers or other mechanical methods and, therefore, requires drilling and blasting.

1. The excavation and disposal of all "Rock Excavation" that is indicated by the Geotechnical Engineering Report shall be considered unclassified excavation and shall be included with site work grading as part of the lump sum base bid.

- ##### B. Trenches: Excavations having vertical sides whose depths exceed its width, made for storm water drainage, sanitary sewer, water, and gas pipes, electric, communications, and steam conduits, and related uses.

#### 1.4 SUBMITTALS

- ##### A. None.

### **PART 2 - PRODUCTS**

- #### 2.1 Not Applicable.

### **PART 3 - EXECUTION**

#### 3.1 PREPARATION

- ##### A. Verify site conditions and note subsurface conditions affecting work of this section.
- ##### B. Identify required lines, levels, and elevations that will determine extent of proposed removals.

#### 3.2 ROCK EXCAVATION

- A. Cut rock to form level bearing at bottom of footing and trench excavations. Remove shale layers to provide sound and unshattered base for footings or foundations. Contractor shall consider reuse of excavated materials on site in accordance with Section 311000. If material cannot be utilized on site, dispose of material offsite.
- B. If placed in embankments, perform rock excavation in manner that will produce material of such size as in accordance with Section 31100. Remove rock to allow for construction and/or installation of the site and building improvements as indicated on Construction Drawings. Remove loose or shattered rock, overhanging ledges and boulders, which might dislodge.
- C. Use lean concrete or suitable materials as directed by registered geotechnical engineer to replace rock over excavation in building and expansion area to facilitate placement of utilities and foundations systems.

3.3 ROCK BLASTING

- A. NO BLASTING SHALL BE ALLOWED ON THIS PROJECT.**

3.4 ROCK CUT FACE EXCAVATION

- A. The slope of the soil above the top of any permanently exposed rock cut face shall be no steeper than 3(H):1(V) unless otherwise noted on the Construction Drawings. Slope of the rock face shall meet the requirements below.

<u>TYPE OF ROCK</u>	<u>SLOPE (Horizontal to Vertical)</u>
Solid limestone or sandstone	1:1.2
Interbedded limestone, sandstone or shale	1:1.25
Layered shale (no hard rock)	1:1.5

- B. Benches of at least ten feet in width at a maximum of twenty feet in elevation intervals or as noted on the Construction Drawings. The benches shall serve to provide rock traps and divert water from the rock face.

3.5 ROCK TRAP

- A. Locate rock traps at the base of permanently exposed rock slopes and construct as indicated in the Construction Documents.

3.6 OVEREXCAVATION AND BACKFILL

- A. Over excavation which is required to remove unsuitable natural undisturbed bedrock weakened by weathering or other cause not inflicted by the Contractor shall be immediately reported to the Owner and performed as directed by the Owner, and the theoretical lines and grades will be adjusted accordingly. Material outside the excavation limits which are disturbed due to the fault or negligence of the Contractor or due to his failure to exercise sound construction practices, shall be either replaced by the Contractor with suitable materials (earth or concrete), or bolted, or both as directed, at no cost to the Owner.

**END OF SECTION 31 20 00**



## **SECTION 31 30 00 - SOIL STABILIZATION**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes
  - 1. Excavation, treatment, and backfilling of subgrade for fly ash or bridge lift stabilization.
  - 2. Geotextile Fabric and/or Geogrid for stabilization of subgrade.
- B. Related Sections
  - 3. Section 31 10 00 - Earthwork

#### 1.2 REFERENCE STANDARDS

- A. American Society for Testing Materials (ASTM)
  - 1. ASTM C 618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
  - 2. ASTM D 1633 - Compressive Strength of Molded Soil-Cement Cylinders
- B. State Highway Department Standard Specifications: "Standard Specifications for State Road and Bridge Construction", Kansas Department of Transportation.

#### 1.3 ENVIRONMENTAL REQUIREMENTS

- A. Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40 degrees Fahrenheit.

#### 1.4 SUBMITTALS

- A. Submit 30-pound sample of each material to be used at the site in airtight containers to the Independent Testing Laboratory or submit gradation and certification of material that is to be used to the Independent Testing Laboratory for review.
- B. Submit name of each materials supplier and specific type and source of each material. Obtain approval of Owner prior to change in source.
- C. Submit mix design and materials mix ratio to Independent Testing Laboratory that will achieve specified requirements as indicated in the documents (or as specified by state and local agencies for soil stabilization if not stated in documents).
- D. If geogrids or geotextiles are to be used, design shall be submitted to Owner for approval.

#### 1.5 QUALITY ASSURANCE

- A. Perform work in accordance with state and local standards in conjunction with requirements specified herein.

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS

- A. Soil Treatment Materials:
  - 1. Fly Ash: ASTM C977 or AASHTO M216

B. Aggregate

1. Coarse Aggregate:: Crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the following gradation requirements:

Sieve Size	Percent Passing
2 inches	100
1 inch	70-100
3/4 inch	50-90
No. 4	30-60
No. 30	7-30
No. 200	0-5

2. Fine Aggregate: Sand – Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter meeting the following gradation requirements:
- 3.

Sieve Size	Percent Passing
No. 4	90-100
No. 50	7-40
No. 200	0-5

C. Subsoil: Existing to be Reused.

- D. Fly ash: Fly ash shall comply with the physical requirements of ASTM D 5239 6.4 maintaining a minimum compressive strength of 3.45 MPa (500 psi) at 7 days and the chemical requirements of ASTM C 618, Table 1, for Class C fly ash. Self-cementing ashes not meeting the above requirements can be used provided the sulfur trioxide content does not exceed 10 percent and the self-cementing properties have been demonstrated to provide the required degree of stabilization. The source of the ash shall be identified and approved in advance of stabilization operations so that laboratory tests can be completed prior to commencing work.

- E. Water: The water used in the stabilized mixture shall be clean, clear, free of sewage, vegetable matter, oil, acid and alkali. Water known to be potable may be used without testing. All other sources shall be tested in accordance with AASHTO T-26 and approved by the Materials Engineer.

F. Equipment

1. The machinery, tools and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning construction operations. Blending of the soil-fly ash mixture shall be accomplished by a Bomag MPH 100 pulvamixer or equivalent. Compaction shall be achieved using a vibratory padfoot roller. Rubber-tired rollers will not be permitted except for finish rolling of the stabilized section. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
2. Fly ash shall be stored and handled in closed weatherproof containers until immediately before distribution. Temporary storage (less than 12 hours) of fly ash in open pits will be allowed provided wetting of the fly ash by rain or groundwater is not allowed. Fly ash exposed to moisture prior to mixing with soils shall be discarded.
3. If fly ash is furnished in trucks, each truck shall have the weight of fly ash certified on public scales or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer.

- G. Bridge Lift Material: Surge stone, granular fill, or shot rock fill.

ACCESSORIES

- H. Curing Seal: Asphalt Emulsion Primer

I. Geotextile Fabric for Stabilization: Provide one of the following:

1. Mirafi 500X or 600X
2. Phillips 66 Supac 6WS
3. Dupont Typar 3401 and 3601
4. Trevira S1114 and S1120
5. Tensar SS-1 and SS-2
6. Exxon GTF-200 or 350
7. TerraTex HD and GS

J. Geogrid for Stabilization: Provide one of the following

1. Tensar BX 1100
2. Tensar BX 1200

2.2 EQUIPMENT

K. Perform operations using suitable, well-maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

**PART 3 - EXECUTION**

3.1 PREPARATION

- A. Obtain approval from the Independent Testing Laboratory of mix design before proceeding with placement.
- B. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
- C. Proofroll subgrade to identify areas in need of stabilization.

3.2 EXCAVATION

- D. Excavate subsoil to depth sufficient to accommodate soil stabilization.
- E. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
- F. Do not excavate within normal 45 degree bearing influence of any foundation.
- G. Notify Construction Manager of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
- H. Correct areas over-excavated in accordance with Section 31 10 00.
- I. Remove excess excavated material from site.

4 GEOTEXTILE FABRIC AND/OR GEOGRID

- J. Place geotextile fabric and/or geogrid over subsoil surface, lap edges and ends in accordance with manufacturer's recommendations in those areas that are shown on Construction Drawings or in those areas that need additional stabilization prior to placement of base course. Bridge lift sections may require the use of geotextile fabric and/or geogrid for stabilization prior to placement of fill.
- K. Place geotextile fabric and/or geogrid in accordance with manufacturer's recommendations.

## 5 SOIL TREATMENT AND BACKFILLING

- L. Fly Ash Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with fly ash.
1. It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform fly ash/soil mixture with no loose or segregated areas; which has a uniform density and moisture content; and which is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his work; to process a sufficient quantity of material to provide a completed section as shown on plans; to use the proper amounts of fly ash; to achieve final compaction within the specified time; to maintain the work; and to rework the lifts as necessary to meet the above requirements. Soil temperature shall be at or above 35° F at the time fly ash is incorporated.
  2. Preparation of Subgrade
    - a. Before other construction operations are begun, the area where the fly ash stabilized material will be placed shall be cut and shaped in conformance with the lines and grades shown on the plans.
    - b. All areas shall be firm and able to support, without displacement, the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable by scarifying, adding fly ash, and compacting until it is of uniform stability.
    - c. When the stabilized section is to extend below the cut surface, the ash shall be distributed uniformly across the surface in a quantity sufficient to provide the specified ash content. The ash shall be incorporated with a pulvamixer with water being added to achieve the specified moisture content
  3. Moisture Control
    - a. Moisture control shall be achieved through use of a pulvamixer equipped with a spray bar in the mixing drum capable of applying sufficient quantities of water to achieve the required moisture content for the soil-fly ash mixture. The system shall be capable of being regulated to the degree necessary as to maintain moisture contents within the specified range.
    - b. Required moisture contents will be established by the Engineer based on laboratory tests with the site soils and specific fly ash to be used for the treatment. Final moisture content of the mix, immediately prior to compaction shall not exceed the specified range of moisture contents. If moisture contents exceed the specified limits, additional fly ash may be added to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of fly ash will not be allowed.
  4. Application of Fly Ash
    - a. Immediately prior to application of fly ash, the area shall be bladed to allow uniform distribution of fly ash.
    - b. The fly ash shall be spread in an approved manner at the rates shown on the plans or as directed by the Engineer.
    - c. The fly ash shall be distributed at a uniform rate and in such manner as to reduce the scattering of fly ash by wind to a minimum. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing fly ash will become objectionable to adjacent property owners.
    - d. Mixing operations shall commence within 1 hour after distribution of the fly ash
  5. Mixing
    - a. The soil and fly ash shall be thoroughly mixed by approved mixers or other approved equipment and the mixing continued until, in the opinion of the Engineer, a homogeneous, friable mixture of soil and fly ash, free from all clods or lumps, is obtained.
    - b. If the soil-fly ash mixture contains clods, they shall be reduced in size by additional pulverization.
  6. Compaction
    - a. Compaction of the mixture shall begin immediately after mixing of the fly ash and be completed within one hour following incorporation of fly ash. Compaction of the mixture shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted to the specified density using padfoot or similar rollers.

- b. All non-uniform (too wet, too dry or insufficiently treated) areas which appear shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and recompacting.
  - c. The stabilized section shall be compacted to a minimum of 95 percent of the material's maximum dry density as determined by ASTM D 698 (standard Proctor compaction). Moisture content of the soil-fly ash mixture shall be in the range developed from laboratory compaction and strength tests.
  - d. In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density or moisture content requirements, the Engineer may require it be reworked as necessary to meet those requirements or require the Contractor to change his construction methods to obtain required density on the next section. Additional fly ash will be added to areas that are reworked and amount required will be established by the engineer. Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of fly ash.
  - e. Placement of fill over the initial stabilized lift shall be delayed 24 hours after final compaction of the stabilized section. Method of fill placement shall be adjusted to minimize disturbance to the stabilized section. Unstable areas that develop during placement of fill shall be undercut below the initial stabilized section. Soils below the undercut area shall be stabilized with self-cementing fly ash and successive lifts of stabilized soil shall be placed to the surrounding grade.
7. Finishing and Curing
- a. After the stabilized section has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections.
  - b. After the fly ash treated course has been finished as specified herein, the surface shall be protected against rapid drying by either of the following curing methods for a period of not less than three days or until the pavement or floor slab is placed:
    - 1) Maintain in a thorough and continuously moist condition by sprinkling.
    - 2) Apply a 2-inch layer of earth on the completed course and maintain in a moist condition.

M. BRIDGE LIFTS:

- 1. Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade by application of a bridge lift. Bridging over existing soils shall be acceptable only when approved in writing by the Owner. Place geotextile fabric or geogrid over existing soils to be bridged. The geotextile fabric or geogrid selected shall be appropriate for the bridge lift material being placed. Place bridge lift over geotextile fabric or geogrid. Surge stone and shot rock will be approved by the Owner's representative on a submittal basis. Depth of bridge lift shall be as determined by the on-site geotechnical engineer. The Owner and the Owner's representative shall have sole discretion as to the acceptability of all submittals.

N. Backfill and compaction of treated subsoil shall be in accordance with Sections 31 10 00.

O. Maintain optimum moisture of mixed materials to attain required stabilization and compaction.

P. Finish subgrade surface in accordance with Section 31 10 00.

Q. Remove surplus mix materials from site.

6 FIELD QUALITY CONTROL

R. Unconfined compression tests on fly ash treated mixture shall be conducted in accordance with ASTM D 1633. Three tests shall be conducted for each mix design tested. Samples shall

be cured at a constant moisture content and temperature for 28 days. Scratch portion of the test shall be omitted.

- S. Field Density: Field in-place density shall be determined as specified in Section 31 10 00. At least one field density test shall be performed for each 250 square yards (or fraction thereof) of each layer of base material.
- T. If tests indicate work does not meet specified requirements, remove work, replace and retest.

**END OF SECTION 31 30 00**

## **SECTION 31 40 00 - EROSION AND SEDIMENTATION CONTROL** **(INCLUDING SWPPP)**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

##### A. Section Includes

1. Installation of temporary and permanent erosion and sedimentation control systems.
2. Installation of temporary and permanent slope protection systems.
3. Prevention of erosion due to construction activities.
4. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
5. Restoration of areas eroded due to insufficient preventive measures.
6. Reimbursement to Owner for costs and fines levied by authorities having jurisdiction due to non-compliance by Contractor.

##### B. Related Sections

1. Section 02 23 00 - Site Clearing
2. Section 31 10 00 – Earthwork
3. Section 33 40 00 – Storm Drainage
4. Storm Water Pollution Prevention Plan, SWPPP (located behind this section)
5. Construction Drawings

#### 1.2 REFERENCE STANDARDS

- A. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus.
- B. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- C. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- E. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- F. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- G. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit.
- H. Kansas Department of Transportation (KDOT) – Standard Specification for State and Road Bridge Construction; latest edition.
- I. American Public Works Association (APWA) – Section 2150 of the Standard Specifications available at [www. http://kcmetro.apwa.net](http://kcmetro.apwa.net)

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of U.S. Environmental Protection Agency and KDHE for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP), whether the project is required by law to comply or not.
- B. Follow the SWPPP and Erosion and Sedimentation Prevention Plan and record periodic inspection reports.
- C. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.
  - 1. Owner will obtain permits and pay for any securities required by authority having jurisdiction.
  - 2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.
  - 3. If applicable, schedule an inspection and receive approval from local jurisdiction for erosion control measures on the site prior to any land disturbance activity.
- D. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- F. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project in accordance with best management practices.
  - 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
- G. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
  - 1. Control movement of sediment and soil from temporary stockpiles of soil.
  - 2. Prevent development of ruts due to equipment and vehicular traffic.
  - 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- H. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
  - 1. Prevent windblown soil from leaving the project site.
  - 2. Prevent tracking of mud onto public roads outside site.
  - 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
  - 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- I. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
  - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
  - 2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.
- J. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
  - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
- K. Open Water: Prevent standing water that could become stagnant.



- L. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

#### 1.4 ENVIRONMENTAL REQUIREMENTS

- A. Protect adjacent properties, any identified endangered or threatened species or critical habitat, any identified cultural or historic resources, and receiving water resources from erosion and sediment damage until final stabilization.
- B. Protect any existing trees or other native areas not shown on the Construction Drawings to be removed.

#### 1.5 SUBMITTALS

- A. Erosion and Sedimentation Control Plan: Owner will obtain the approval of the Plan by authorities having jurisdiction.
- B. Inspection Reports: Keep a record copy after each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished. Provide copies of the inspection reports upon request to Owner.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Curlex blankets by American Excelsior Company.
- B. Temporary mulches such as loose straw, netting, wood cellulose, or agricultural silage.
- C. Rip-Rap or Rock for checks and other rock BMP's shall be as specified in Construction Drawings.
- D. Temporary and permanent outfall structures as specified on the drawings.
- E. Grass Seed For Temporary Cover: Select a quick growing grass species (such as wheat, rye or oats) appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.
- H. Bales: Not allowed.
- J. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
  1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
  2. Permittivity:  $0.05 \text{ sec}^{-1}$ , minimum, when tested in accordance with ASTM D4491.
  3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
  4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
  5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
  6. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D4533.
  7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
  8. Manufacturers: Provide products by one of the following or equal:
    - a. TenCate.

- b. North American Green.
  - c. Other approved equal (by Engineer)
- K. Silt Fence Posts: One of the following, minimum 5 feet long:
- 1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot.
  - 2. Hardwood, 2 by 2 inches in cross section.
- L. Gravel: Crushed limestone (KDOT AB-3) or crushed concrete.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

#### **3.2 PREPARATION**

- A. Review the drawings and Storm Water Pollution Prevention Plan.
- B. Revise SWPPP if necessary to address potential pollution from site identified after issuance of the SWPPP at no additional cost to the owner.
- C. Conduct pre-construction meeting with Site Contractor, Owner, Engineer, Inspector from local municipality (if appropriate).
- D. Schedule work so that soil surfaces are left exposed for the minimum amount of time.
- E. Place erosion control systems in accordance with the drawings and Storm Water Pollution Prevention Plan or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
- F. Deficiencies or changes on the drawings or Storm Water Pollution Prevention Plan shall be corrected or implemented as site conditions change. Changes during construction shall be noted in the Storm Water Pollution Prevention Plan and posted on the drawings (Site Map).
- G. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.X
- H. Maintain temporary erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or Owner to control sediment until final stabilization. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities immediately, but in no case, within not more than 3 days if required at no additional cost to the Owner.
- I. Contractor shall incorporate permanent erosion control features, paving, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.
- J. Permanently seed and mulch cut slopes as excavation proceeds to extend considered desirable and practical.

- K. Slopes that erode easily or that will not be graded for a period of 14 days or more shall be temporarily seeded as work progresses with wheat, rye, or oats application. In the event it is not practical to seed areas, slopes must be stabilized with geotextile fabric or other means to reduce the erosive potential of the area.

### 3.3 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed, temporary preventive measures are not required and can be eliminated or removed.
- B. Construction Entrances: Traffic-bearing aggregate surface.
  - 1. Width: As required; 20 feet, minimum.
  - 2. Length: 50 feet, minimum.
  - 3. Provide at each construction entrance from public right-of-way, or immediate paved surface if on private property.
  - 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- C. Linear Sediment Barriers: Made of silt fences.
  - 1. Provide linear sediment barriers where indicated on the Drawings and as follows:
    - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
    - b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
    - c. Along the toe of cut slopes and fill slopes.
    - d. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart.
    - e. Across the entrances to culverts that receive runoff from disturbed areas.
  - 2. Space sediment barriers with the following maximum slope length upslope from barrier:
    - a. Slope of Less Than 2 Percent: 100 feet.
    - b. Slope Between 2 and 5 Percent: 75 feet.
    - c. Slope Between 5 and 10 Percent: 50 feet.
    - d. Slope Between 10 and 20 Percent: 25 feet.
    - e. Slope Over 20 Percent: 15 feet.
- D. Storm Drain Curb Inlet Sediment Barrier: Protect curb inlets with rock, silt fence or other measures as indicated on the Drawings.
- E. Area Inlet Sediment Traps: As detailed on Drawings, protect with one of the following means:
  - 1. Filter fabric sock blocking entire inlet perimeter. Secure to prevent dislodging; orient so runoff passes into inlet.
  - 2. Filter fabric with stone/rock to hold down blocking inlet.
- F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.
- G. Soil Stockpiles: Protect using one of the following measures:
  - 1. Cover with polyethylene film, secured by placing soil on outer edges.
  - 2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.
- H. Temporary Seeding: Use where temporary vegetated cover is required.

### 3.4 INSTALLATION

- A. Traffic-Bearing Aggregate Surface:

1. Excavate minimum of 6 inches.
  2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
  3. Place and compact at least 6 inches of aggregate.
- B. Silt Fences:
1. Store and handle fabric in accordance with ASTM D4873.
  2. Install with top of fabric at nominal height and embedment as indicated on the Drawings.
  3. Embed bottom of fabric in a trench on the upslope side of fence, with 2 inches of fabric laid flat on bottom of trench facing upslope; backfill trench and compact.
  4. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
  5. Fasten fabric to wood posts using one of the following:
    - a. Four nails per post with 3/4 inch diameter flat or button head, 1 inch long, and 14 gage, 0.083 inch shank diameter.
    - b. Five staples per post with at least 17 gage, 0.0453 inch wire, 3/4 inch crown width and 1/2 inch long legs.
  6. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
  7. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
- C. Straw Bale Rows:
1. Not allowed.
- D. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
  2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
  3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1,000 sq ft.
  4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1,000 sq ft.
  5. Incorporate fertilizer into soil before seeding.
  6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
  7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
  8. Repeat irrigation as required until grass is established.

### 3.5 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.
- C. Silt Fences:
1. Promptly replace fabric that deteriorates unless need for fence has passed.
  2. Remove silt deposits that exceed one-third of the height of the fence.
  3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Straw Bale Rows:
1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
  2. Remove silt deposits that exceed one-half of the height of the bales.
  3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

- E. Clean out temporary sediment control structures weekly and relocate soil on site.
- F. Place sediment in appropriate locations on site; do not remove from site.

### 3.7 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

**END OF SECTION 31 40 00**

## **SECTION 32 10 00 - ASPHALTIC CONCRETE PAVING**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Preparation and placement of asphaltic concrete base course.
- B. Preparation and placement of asphaltic concrete surface course.

#### 1.2 RELATED SECTIONS

- A. Section 31 10 00 - Earthwork
- B. Section 32 20 00 – Portland Cement Concrete Paving
- C. Section 32 30 00 - Pavement Markings
- D. Construction Drawings

#### 1.3 REFERENCE STANDARDS

- A. The Asphalt Institute (AI) latest edition
  - 1. MS 2 Mix Design Methods for Asphaltic Concrete and Other Hot Mix Types
  - 2. MS 3 Asphalt Plant Manual
  - 3. MS 8 Asphalt Paving Manual
  - 4. MS 19 Basic Asphalt Emulsion Manual
- B. "Standard Specifications for State Road and Bridge Construction," Kansas Department of Transportation, including all revisions.
- C. American Society for Testing and Materials (ASTM) latest edition
  - 1. D 946 Penetration - Graded Asphalt Cement for use in Pavement Construction
  - 2. D 1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
  - 3. D 1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- D. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - 1. M 117 Mineral Filler "Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing"
  - 2. M 140 Tack Coat "Emulsified Asphalt"
  - 3. M 208 Tack Coat "Cationic Emulsified Asphalt"
  - 4. M 226 Viscosity Graded Asphalt Cement
  - 5. T 245 Marshall Mix Design
- E. Manual of Uniform Traffic Control Devices (M.U.T.C.D.), latest edition.
- F. American Public Works Association (APWA) Standard Specifications and Design Criteria – KC Metro Area, Section 2200, latest edition, which may be downloaded here: <http://kcmetro.apwa.net>

#### 1.4 QUALITY ASSURANCE

- A. An independent testing laboratory, selected and paid by Owner, shall be retained to perform construction testing of in-place asphaltic concrete courses for compliance with requirements for thickness, compaction, and surface smoothness.

- B. In-place compacted thickness shall not be less than thickness specified on Construction Drawings. Areas of deficient paving thickness shall receive tack coat and minimum 1-in. overlay; or shall be removed and replaced to proper thickness, at discretion of Owner; until specified thickness of course is met or exceeded at no additional expense to Owner.
- C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

## 1.5 SUBMITTALS

- A. Before asphaltic concrete paving is constructed, submit actual design mix to Engineer and Owner's independent testing laboratory for review and approval. Design mix submittal shall follow a format as indicated in Asphalt Institute Manual MS-2, Marshall Stability Method; and shall include type/name of mix, gradation analysis, grade of asphalt cement used, Marshall Stability in pounds (lb.) flow, effective asphalt content in percent (%), and direct references to state highway department specifications sections for each material. Design shall be for mixture listed in current edition of state highway department specifications. Mix designs over 2 years old will not be accepted by Owner.
- B. Submit materials certificate to the independent testing laboratory that is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein.

## 1.6 PROJECT CONDITIONS

- A. Weather Limitations:
  1. Apply tack coats when ambient or base surface temperature is above 40 degrees Fahrenheit, and when temperature has been above 35 degrees Fahrenheit for 12 hours immediately prior to application. Do not apply when asphalt is wet, contains excess moisture, during rain, or frozen.
  2. Construct asphaltic concrete base course paving when atmospheric temperature is above 40 degrees Fahrenheit and rising.
  3. Construct asphaltic concrete surface course paving when atmospheric temperature is above 50 degrees Fahrenheit and rising.
- B. Provide adequate traffic control as may be required given the project conditions. Follow M.U.T.C.D. requirements. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Asphaltic surface course shall be APWA Type 3. Reclaimed Asphalt Content (RAC) may be used up to 30% of the mix design.
- B. Asphaltic base course shall be APWA Type 1. Reclaimed Asphalt Content (RAC) may be used up to 30% of the mix design.
- C. Tack Coat: Emulsified asphalt; AASHTO M 140 or AASHTO M 208, SS-1h, CSS-1, or CSS-1h, diluted with 1 part water to 1 part emulsified asphalt.

### 2.2 EQUIPMENT

- A. All equipment necessary for the paving of asphaltic concrete shall be on the project prior to beginning paving operations.

- B. Maintain equipment in satisfactory operating condition and correct breakdowns in manner that will not delay or be detrimental to the schedule of paving operations.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Within 48-hours prior to paving, proofroll prepared base material or subgrade surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving. Do not pave on soft or frozen subgrades. Correction of unsuitable areas shall be at no additional costs to the Owner.
- B. Remove loose material from compacted base material surface.
- C. Establish and maintain required lines and elevations.
- D. Cover the surfaces of curbs, gutters, manholes and other structures the asphaltic concrete mixture will be placed against with a thin, uniform coat of liquid asphalt. Where the asphaltic concrete mixture will be placed against the vertical face of an existing pavement, clean the vertical face to remove foreign substances and apply a coating of liquid asphalt at a rate of approximately 0.25 gallons per square yard.

#### **3.2 APPLICATIONS**

- A. Prime Coat:
  1. Not required.
- B. Tack Coat:
  1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
  2. Apply tack coat to asphaltic concrete base course or sand asphalt base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete and sand asphalt bases and on surface of bases where asphaltic concrete paving will be constructed.
  3. Apply emulsified asphalt tack coat in accordance with state highway department specifications.
  4. Apply at minimum rate of 0.05 gal per sq. yd of surface.
  5. Allow drying until at proper condition to receive paving.

#### **3.3 ASPHALTIC CONCRETE PLACEMENT**

- A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:
  1. Asphaltic Surface Course: Ambient temperature 50 degrees and rising.
  2. Asphaltic Base Course: Ambient temperature 40 degrees and rising.
- B. Whenever possible, spread pavement by finishing machine; however, inaccessible or irregular areas may be placed by hand methods. Spread hot mixture uniformly to required depth with hot shovels and rakes. After spreading, carefully smooth hot mixture to remove segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be type designed for use on asphalt mixtures. Do not dump loads faster that they can be properly spread. Workers shall not stand on loose mixture while spreading.
- C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with surface course placed parallel to flow of traffic. Place asphaltic paving in typical strips not less than 10'-0" wide. Two (2) or more equal lifts required if same materials are used, each lift



being no thicker than 3 inches, **no** less than 1 inch. Under no circumstances will only one lift of asphalt concrete paving be allowed.

- D. Joints: Make joints between old and new pavements, or between successive days and work in manner that will provide continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete surface course. Clean contact surfaces of joints and apply tack coat.

### 3.4 ROLLING AND COMPACTION

- A. Mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in workable condition.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.

### 3.5 JOINTS

- A. General
  1. Place each asphaltic paving layer as continuous as possible to keep the number of joints to a minimum. Create joints between old and new pavement, between successive days' work, and where the mixture has become cold (less than 140 degrees F). Make these joints in such a manner as to create a continuous bond between the old and new pavement construction courses.
  2. Offset successive courses by at least 6 inches.
- B. Transverse Joints: If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smoothness. If the temperature of the previously placed pavement material drops below 140 degrees F before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just before paving is continued.

- C. Longitudinal Joints: Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F, with liquid asphalt just before paving is continued.

### 3.6 FIELD QUALITY CONTROL

- A. Asphaltic surface and base courses will be randomly cored at minimum rate of 1 core per 20,000 sq. ft of paving. However, a minimum of 3 cores in light duty areas and 3 cores in heavy-duty areas shall be obtained. Core holes shall be tack coated and immediately filled with full-depth asphaltic concrete. Asphaltic concrete pavement samples will be tested for conformance with mix design.
- B. Testing will be performed on finished surface of each asphalt concrete course for smoothness, using 10'-0" straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be accepted if the following 10-foot straightedge tolerances for smoothness are exceeded:

Base Course Surface: 1/4-inch  
Wearing Course Surface: 1/8-inch

- C. Field density test for in-place materials shall be performed by examination of field cores in accordance with one of following standards:
1. AASHTO Test Method T 245 (Percent of Laboratory Density)
    - a. Temperature equal to temperature at paving machine with reheating.
    - b. Compactive blows (35, 50, or 75) equal to mix design blows.
    - c. Minimum density = 96% of laboratory density.
  2. AASHTO Test Method T 209 (Percent of Theoretical Maximum Density)
    - a. Minimum density = 92% of Theoretical Maximum Density.
- D. Areas of insufficient compaction, smoothness and thickness shall be delineated, removed, and replaced in compliance with Specifications at no additional expense to Owner.

**END OF SECTION 32 10 00**

## **SECTION 32 20 00 - PORTLAND CEMENT CONCRETE PAVING**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Preparation and placement of portland cement concrete parking areas.
- B. Preparation and placement of portland cement concrete roads and entrances.
- C. Preparation and placement of Portland cement concrete curbs and sidewalks

#### 1.2 RELATED SECTIONS

- A. Section 31 10 00 - Earthwork
- B. Section 32 30 00 - Pavement Markings
- C. Construction Drawings

#### 1.3 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) latest edition
  - 1. 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 2. 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 3. 305R Hot Weather Concreting
  - 4. 306R Standard Specification for Cold Weather Concreting
  - 3. 308 Standard Practice for Curing Concrete
- B. American Society for Testing and Materials (ASTM) latest edition
  - 1. A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 2. A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
  - 3. C33 Concrete Aggregates
  - 4. C78 Method for Flexural Strength Concrete (Using Simple Beam with Third-point Loading)
  - 5. C94 Ready-Mixed Concrete
  - 6. C143 Method for Slump of Hydraulic Cement Concrete
  - 7. C150 Portland Cement
  - 8. C171 Sheet Material for Curing Concrete
  - 9. C231 Air-Content of Freshly Mixed Concrete by the Pressure Method
  - 10. C260 Air-Entraining Admixtures for Concrete
  - 11. C309 Liquid Membrane-Forming Compounds for Curing Concrete
  - 12. C494 Chemical Admixtures for Concrete
  - 13. C920 Standard Specification for Elastomeric Joint Sealants
  - 14. D994 Preformed Expansion Joint Filler for Concrete (Bituminous)
  - 15. D1190 Concrete Joint Sealer, Hot Poured, Elastic Type
  - 16. D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
  - 17. D2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- C. Federal Specifications (FS)
  - 1. FS HH-F-341 - Fillers,Expansion Joint:Bituminous(Asphalt & Tar)
  - 2. FS TT-C-800 – Curing Compound, Concrete, for New and Existing Surfaces.

- D. "The Design of Concrete Pavements for City Streets", by the Portland Cement Association
- E. "Standard Specifications for State Road and Bridge Construction," Kansas Department of Transportation, including all revisions.
- F. KANSAS CITY METROPOLITAN MATERIALS BOARD (KCMMB) SPECIFICATIONS. Available at [www.kcmmmb.org](http://www.kcmmmb.org)

#### 1.4 QUALITY ASSURANCE

- A. Establish and maintain required lines and elevations.
- B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.
- C. Broom finish surfaces with Fibermesh Reinforcement may have a slight fuzzy or hairy appearance, which in time (4 to 8 months) will wear off. At the engineers and/or owners discretion the fiber hairs shall be removed by means of propane torch. A constant motion of the torch shall be used to avoid discoloration to the concrete surface. Torching of fiber hairs shall be performed prior to the application of joint sealants.

#### 1.5 SUBMITTALS

- A. Submit materials certificate from materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the Engineering Consultant of Record and the independent testing laboratory for review and approval and within 7 calendar days after receipt of Notice-to-Proceed, submit for approval, certified laboratory test data or manufacturers certificates and data for the following items:
  - 1. Portland cement concrete mix
  - 2. Aggregate gradations
  - 3. Preformed expansion joint filler
  - 4. Field molded/poured sealant
  - 5. Dowel bars
  - 6. Expansion sleeves
  - 7. Tie bars
  - 8. Reinforcing steel bars
  - 9. Welded wire fabric
  - 10. Air entraining admixtures
  - 11. Water-reducing and set-retarding admixtures (if used)
  - 12. Certification that all aggregate meets or exceeds Durability Class I and complies with KDOT Standard Specification, Sections 1101 and 1102, signed by both the materials producer and contractor.
- B. Concrete jointing layout plan in accordance with the Portland Cement Association recommendations.
- C. Aggregates shall meet KCMMB requirements.
- D. Material certificates which are submitted shall be signed by both the Materials Producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein to the

Civil Engineering Consultant of Record and the independent testing laboratory for review and approval.

## 1.6 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities and for general public as may be appropriate. Coordinate access changes with Owner. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as may be required.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Coat forms with nonstaining type of coating that will not discolor or deface surface of concrete.
- B. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60. . Bar supports shall be CRSI Class 1, plastic protected, or Class 2, stainless steel protected.
- C. Portland Cement: Shall conform to ASTM C150, Type I. High early strength concrete, where specified on the Construction Drawings or where required to minimize the time of traffic closures or detours, may be required on this project. High early strength concrete shall have a minimum compressive strength of 3,000 pounds per square inch in 24 hours. Early strength may be achieved by the addition of extra cement, use of Type III cement, or the addition of non-chloride accelerating admixture.
- D. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D994, D1751, D2628; FS HH-F-341, Type II, Class A or approved equal.
- E. Joint Sealants: Conforming to ASTM C920, non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "SL1", Sonneborn "SL2", Sonneborn "Sonomeric 1", Sonneborn "Sonomeric 2", Mameco "Vulkem 245", or Woodmont Products "Chem-Caulk" or approved equal.
- F. Aggregate: Shall conform to ASTM C33. Refer to KCMMB requirements for large aggregate.
- G. Water: Shall be clean and potable
- H. Dowel Bars: Shall conform to ASTM A615, grade 60, and plain steel bars.
- I. Air Entraining Mixture: Shall conform to ASTM C260 (Sika AER by Sika Corporation, Air Mix by the Euclid Chemical Corporation or approved equal).
- J. Curing Compound: Shall conform to ASTM C309 (Polyseal 4 in 1 by Chem Masters Corporation or approved equal).
- K. Joint Backup Rods: Shall be CCEVA Rod 100 by E-Poxy Industrials, Inc., Sealtight BACKER ROPE by W.R. Meadows, Inc. or approved equal.

### 2.2 MIX DESIGN

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following properties:
  - 1. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
  - 2. Slump Range: 2"-4" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
  - 3. Air Entrainment: 6.5 percent, plus or minus 1.5 percent.
  - 4. **MIX DESIGN SHALL BE KCMMB 4K for all site work concrete, both public and private.**

## 2.3 CONCRETE TESTING

- A. Curb: Test for Slump and air every fifty (50) cubic yards or a minimum of once per working day. One set of three (3) concrete cylinders to be made for every fifty (50) cubic yards or a minimum of once per working day.
- B. Flat Work: Test for slump and air every fifty (50) cubic yards or a minimum of once per working day. One set of four (4) concrete cylinders to be made for every one hundred (100) cubic yards or a minimum of once per working day.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Within 48-hours prior to paving, proofroll prepared base material or subgrade surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving. Do not pave on soft or frozen subgrades. Correction of unsuitable areas shall be at no additional costs to the Owner.
- B. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.
- C. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

### 3.2 INSTALLATION

- A. Form Construction
  - 1. Set forms to required grades and lines, rigidly braced and secured.
  - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
  - 3. Check completed formwork for grade and alignment to following tolerances:
    - a. Top of forms not more than 1/8-inch in 10'-0"
    - b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0"
  - 4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
- C. Concrete Placement

1. Concrete may be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
  2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at required finish elevation and alignment.
  3. Place concrete using methods that prevent segregation of mix. Flatwork shall be struck off with a vibratory truss screed or roller screed and hand vibrators. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator, when the area is inaccessible with a vibrating screed. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
  4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2-hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable to the Owner, remove and replace with formed concrete as specified herein.
- D. Contraction and Construction Joints: Construct contraction and construction joints straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline, unless otherwise detailed.
1. Contraction Joints: Provide joints at spacing of 12'-0" on centers, maximum each way. Construct control joints for depth equal to at least 1/3 of the concrete thickness, as follows:
    - a) Form tooled joints in fresh concrete by grooving top with recommended tool and finishing edge with jointer.
    - b) Sawed Contraction Joints:
      - 1) Use saws, blades, skid plates, and accessories by Soff-Cut International, Inc. or approved equal.
      - 2) Start cutting sawed joints as soon as concrete has hardened sufficiently to prevent raveling or dislodging of aggregates. This will typically be from 1 hour in hot weather to 4 hours in cold weather after completing finishing of slab in that joint location.
      - 3) Provide at least two "Soff-Cut" saws on site with blades capable of achieving the required depth of saw cut.
      - 4) Extend sawed joint to the slab boundaries and abutments, including columns, drains, and other penetrations in the path of a defined joint. Implement methods and timing of the saw cut beyond the limits of the Soff-Cut saw reach to provide a consistent depth of cut with minimal raveling of joint edges.
  2. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour. Construct joints in accordance with details shown.

Isolation and Fixed Object Joints: Construct joint at locations and in accordance with details shown.

Pavement Joint Materials: Place joint fillers, back-up material, and sealants at locations shown and in accordance with manufacturer's instructions.

2. Soft Preformed Joint Fillers: Extend preformed joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface. Furnish preformed joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip preformed joint filler sections together in a single plane.
- E. Joint Construction for Curbs and Sidewalks:
1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by with 3/4-inch thick

performed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold its shape, but shall be removed while forms are still in place.

2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
  3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.
- F. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.
- G. Joint Sealants: All Joints shall be sealed with approved exterior pavement joint sealants and shall be installed in accordance with manufacturer's recommendations.

### 3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of slabs, sidewalks, gutters, back top edge of curb and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
1. Inclined Slab Surfaces: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.
  2. Paving: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to flow of traffic so as to produce regular corrugations not over 1/16 of an inch deep.
  3. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Owner.
- D. Protect and cure finished concrete paving using a liquid membrane forming compound in accordance with KDOT Standard Specification Section 502. The liquid membrane forming compound shall be capable (as certified by the manufacturer) of both curing and sealing the concrete.

### 3.4 BACKFILL

- A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with Section 31 10 00.



**3.5 CLEANING AND PROTECTION**

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement, (except for high early strength areas—and then only allow traffic after pavement has reached 3,000 psi minimum compressive strength). When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

**END OF SECTION 32 20 00**

## **SECTION 32 30 00 - PAVEMENT MARKINGS**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

#### 1.2 Section Includes

1. Painting and marking of pavements, curbs and guard posts.

#### 1.3 REFERENCE STANDARDS

##### A. American Association of State Highway and Transportation (AASHTO)

1. AASHTO M248 - Ready-Mixed White and Yellow Traffic Paints

##### B. American Society for Testing and Materials (ASTM)

1. ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness by Notched Gauges.

##### C. Federal Specifications (FS)

1. FS A-A-2886 - Paint, Traffic, Solvent Based (supersedes FS TT-P-85 and FS TT-P-115, Type I)
2. FS TT-P-1952 - Paint, Traffic And Airfield Marking, Waterborne

#### 1.4 PROJECT CONDITIONS

- ##### A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required.

#### 1.5 QUALITY ASSURANCE

- ##### A. Use trained and experienced personnel in applying the products and operating the equipment required for properly performed work.

- ##### B. Testing of wet film thickness shall be performed a minimum of two (2) times on each parking row (including striped islands) and pedestrian cross walks, and a minimum of one (1) test on each lane/alignment striping. At least one test shall be performed after refilling paint striping machine, changing operators of machine, or changing paint types or brands (This shall be in addition to the tests stated above). These tests shall be performed on each coat applied. Testing shall be per ASTM D4414-95 (2001).

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS

- ##### A. Manufacturer's certificate: Certify that products meet or exceed specified local requirements and the requirements of this specification.

- ##### B. Paint shall be waterborne, or solvent borne, colors as shown or specified herein. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

- ##### C. Waterborne Paint: Paints shall conform to FS TT-P-1952,

- D. Solvent Borne Paint: Paint shall conform to FS A-A-2883 or AASHTO M248. Paint shall be non-bleeding, quick-drying, and alkyd petroleum base paint suitable for traffic-bearing surface and be mixed in accordance with manufacture's instructions before application for colors White, Yellow, Blue, and Red.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine the work area and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

#### **3.2 PREPARATION**

- A. Sweep and clean surface to eliminate loose material and dust. Where sweeping does not adequately remove dirt, Contractor may need to power wash pavement prior to painting.
- B. Where existing pavement markings are indicated on Construction Drawings to be removed or would interfere with adhesion of new paint, a motorized abrasive device shall be used to remove the markings. Equipment employed shall not damage existing paving or create surfaces hazardous to vehicle or pedestrian traffic. Within public rights-of-way, appropriate governing authority shall approve method of marking removal.

#### **3.3 CLEANING EXISTING PAVEMENT MARKINGS**

- A. In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or do not interfere with the adhesion of the new marking material do not require removal. Whenever grinding, scraping, sandblasting or other operations are performed, the work shall be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

#### **3.4 APPLICATION**

- A. Apply **two** coats of paint at manufacturer's recommended rate, without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7 ½ mils per coat. Paint shall be applied for a total dry film thickness of 15 mils. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use straightedge to ensure uniform, clean, and straight stripe.
- B. Install pavement markings according to manufacturer's recommended procedures for the specified material.
- C. Following items shall be painted with colors noted below:
  1. Pedestrian Crosswalks: White
  2. Fire Lanes: Red or per local code
  3. Lane Striping where separating traffic moving in opposite directions: Yellow
  4. Lane Striping where separating traffic moving in the same direction: White
  5. ADA Symbols: Blue or per local code
  6. ADA parking space markings as shown on the drawings.
  7. Parking Stall Striping: White, unless otherwise noted on Construction Drawings

### 3.5 FIELD QUALITY CONTROL

- A. Inspection: After the paint has thoroughly dried, visually inspect the entire application and touch up as required to provide clean, straight lines and surfaces throughout.
- B. Testing: Testing of wet film thickness shall be performed a minimum of two times on each parking row (including striped islands) and pedestrian cross walks, and a minimum of one test on each lane/alignment striping. At least one test shall be performed after refilling paint striping machine, changing operators of striping machine, and changing paint types, brands, etc. This shall be performed in addition to the testing stated above. These tests shall be performed on each coat applied. Testing shall be performed in accordance with ASTM D4414.

### 3.6 CLEANING AND PROTECTION

- A. Waste materials shall be removed at the end of each workday. Upon completion of the work, all containers and debris shall be removed from the site. Paint spots upon adjacent surfaces shall be carefully removed by approved procedures that will not damage the surfaces and the entire job left clean and acceptable.
- B. Pavement markings damaged after painting before the project has been accepted may be required to be repainted at the Contractor's expense. Contractor shall take care to protect pavement markings from unnecessary wear during construction of the project.

**END OF SECTION 32 30 00**

## **SECTION 32 32 23 - SEGMENTAL RETAINING WALL SYSTEMS**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes:
  1. Segmental retaining wall (SRW) units, soil reinforcement, and appurtenances.
- B. Related Requirements:
  1. Section 31 10 00 – Earthwork
  2. Section 33 40 00 – Storm Drainage

#### 1.2 Description

- A. Work shall consist of designing, furnishing and construction of Segmental Block Retaining Wall System in accordance with these specifications and in reasonably close conformity with the lines, grades, design, and dimensions shown on the plans.
- B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit drainage fill and backfill to the lines and grades shown on the construction drawings.
- C. Work includes furnishing and installing geogrid soil reinforcement of the type, size, location, and lengths designated on the construction drawings.

#### 1.3 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
- B. ASTM International (ASTM):
  1. ASTM C140 - Sampling and Testing Concrete Masonry Units and Related Units.
  2. ASTM C150 - Portland Cement.
  3. ASTM C1262 - Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units.
  4. ASTM C1372 - Dry-Cast Segmental Retaining Wall Units.
  5. ASTM D422 - Particle-Size Analysis of Soils.
  6. ASTM D698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 Ft-Lbf/Ft 3(600 Kn-M/M 3)).
  7. ASTM D2166 - Unconfined Compressive Strength of Cohesive Soil.
  8. ASTM D2949 - 3.25-in. Outside diameter poly (vinyl chloride) (pvc) plastic drain, waste, and vent pipe and fittings.
  9. ASTM D2922 - Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  10. ASTM D3080 - Direct Shear Test of Soils Under Consolidated Drained Conditions.
  11. ASTM D4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  12. ASTM G51 - Measuring Ph of Soil for Use in Corrosion Testing.
  13. ASTM G57 - Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.
- C. National Concrete Masonry Association (NCMA):
  1. NCMA - Design Manual for Segmental Retaining Walls.
  2. NCMA SRWU-2 - Shear Strength between Segmental Concrete units.
- D. American Association of Highway and Transportation Officials (AASHTO):
  1. AASHTO - Standard Specifications for Highway Bridges.

#### 1.4 DEFINITIONS

- A. Soil Reinforcement: Structural geogrid or steel strips formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as structural reinforcement.
  - 1. Geosynthetic (extensible) Soil Reinforcement: Polymer product specifically manufactured as soil reinforcement element that meets requirements of this specification.
  - 2. Steel (inextensible) Soil Reinforcements: Steel strips, wires, or bars specially configured and coated for soil reinforcement applications.
- B. Segmental Concrete Facing Unit: A modular concrete facing unit machine-made from Portland cement, water, and mineral aggregates.
- C. Cap Unit: A modular concrete cap unit machine-made.
- D. Unit Fill: Free draining "open" aggregate fill which is within and between the segmental concrete facing units.
- E. Drainage Fill: Free draining "open" aggregate fill extending a minimum of 12" behind the units.
- F. Reinforced Backfill: Compacted soil which is within the reinforced soil volume as outlined on Construction Drawings.
- G. Foundation Soil: Compacted import or in-situ soil beneath entire wall.
- H. Retained Soil: Compacted import or in-situ soil behind reinforced zone of retaining wall.
- I. Leveling Pad: Level compacted gravel or unreinforced concrete footing upon which first course of segmental concrete facing units are placed.

#### 1.5 SUBMITTALS / CERTIFICATIONS

- A. Contractor shall submit a Manufacturer's certification, prior to start of work, that the retaining wall system components meet the requirements of this specification and the structure design.
- B. Contractor shall submit construction drawings and design calculations for the retaining wall system prepared and stamped by a Professional Engineer registered in the state of the project. The engineering designs, techniques, and material evaluations shall be in accordance with the more stringent of NCMA - Design Manual for Segmental Retaining Walls and manufacturer's design criteria (if any). Contractor shall provide evidence that the design engineer has a minimum of five years of documental experience in the design for reinforced soil structures. The design engineer shall provide proof of current professional liability insurance with an aggregate coverage limit of not less than \$2,000,000.

#### 1.6 QUALITY ASSURANCE

- A. Qualifications: SRW system installer shall have a minimum of 100,000 square feet of documentable experience installing SRW systems over eight feet in height on minimum of five projects over the previous two years. Provide to the Owner at the pre-construction conference, a project list with current references and telephone numbers for the proposed SRW Installer substantiating the required experience.
- B. Pre-Construction Meeting: A pre-construction meeting shall be conducted by the General Contractor prior to beginning construction on segmental retaining walls. Owner's Construction Manager shall be notified of the date, time, and location of the meeting. Mandatory attendees include the General Contractor, the wall design engineer of record, the project geotechnical engineer, the Contractor's testing agency, Owner's independent testing laboratory, and representatives of all sub-contractors involved with the foundation preparation, erection, and backfilling of the SRW. Meeting topics shall include, but are not limited to contractor qualifications as stated above; schedule and phasing of wall construction; coordination with other on-site construction activities; responsibilities of parties; and sources, quality, and acceptance of materials.

- C. Owner shall/may provide soil testing and quality assurance inspection during earthwork and wall construction operations. Contractor shall provide any quality control testing or inspection not provided by the Owner. Owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.
- B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.
- C. Segmental Concrete Facing Units:
  1. Check the materials upon delivery to assure the specified type, grade, color and texture of units have been received.
  2. Prevent excessive mud, wet concrete, epoxies, and like materials which may affix themselves from coming in contact with the materials.
  3. Protect the materials from damage.
- D. Soil Reinforcement:
  1. Check the soil reinforcement upon delivery to assure the proper grade and type of material been received. Provide a product certification with each shipment.
  2. Store soil reinforcement material in accordance with manufacturer's recommendations.
- E. Drainage Materials:
  1. Store plastic pipe in accordance with the manufacturer's recommendations to prevent deleterious materials from becoming affixed or deterioration from sun exposure.
  2. Store drainage aggregate to prevent contamination with other materials.

### PART 2 - PRODUCTS

#### 2.1 SEGMENTAL CONCRETE FACING UNITS

- A. Manufacturers: Provide SRW system based on the following manufactured system.
  1. Keystone Standard Unit – Straight, Hard split face
  2. Versa-lok Standard Unit – Straight, Hard split face
  3. Redi-Rock Large block gravity wall system – Limestone face, stained.
- B. Substitutions: Submit product information to Owner for approval prior to bid. Owner reserves right to reject any and all substitutions.
- C. Color and finish shall be as shown in the Drawings, or if not specified shall be earthtone buff color.
- D. Facing units shall meet the following structural requirements:
  1. SRW Shear Capacity: Concrete units shall have a demonstrated shear capacity to withstand laterally applied shear loads as defined in the design calculations. Shear capacity shall be demonstrated through full-scale testing of SRW facing system according to NCMA SRWU-2 test method. Shear capacity shall be defined both with and without the soil reinforcement present at the interface.
  2. Units shall be manufactured in accordance with ASTM C1372.
  3. Concrete wall units including cap units shall have minimum 28-day compressive strength of 4,000 psi on the net area and have a maximum absorption rate of 6 percent.
  4. Cementitious materials used in manufacture of units shall be Type I, Type II or Type III Portland cement in accordance with ASTM C150.

5. In areas where repeated freezing and thawing under saturated conditions occur, freeze-thaw durability shall be demonstrated by testing per ASTM C1262. Testing shall be conducted for a minimum 100 cycles, and weight loss shall not exceed one percent.
6. Other Constituents: Air entraining agents, coloring pigments, integral water repellents, finely ground silica and other constituents shall be previously established as suitable for use in retaining wall units or shall be shown by test or experience not to be detrimental to the durability of segmental concrete facing units or to any material used in masonry construction.
7. Dimensional tolerances for exterior molded units shall be in accordance with ASTM C1372. SRW concrete facing unit molded dimensions shall not differ more than  $\pm 1/8$  inch from the manufacturer's published dimensions, except for height which shall be  $\pm 1/16$ -inch. Maximum differential shall be no more than  $1/8$  inch in height from front to back of unit.
8. SRW units shall provide minimum effective in-place weight equivalent to 100 pcf. Fill placed within dimensions of units may be considered as integral to the effective unit weight. This in-place weight shall be determined by testing and used for all design calculations.
9. Units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction.

## 2.2 BASE LEVELING PAD MATERIAL

- A. Base leveling pad material shall be crushed dense aggregate base material or lean non-reinforced 2,000 psi concrete.

## 2.3 UNIT FILL

- A. Unit fill shall be free-draining crushed stone or crushed gravel conforming to SRW manufacturer's recommendations.

## 2.4 SOIL REINFORCEMENT

- A. Geosynthetic Soil Reinforcement:
  1. Properties: The geosynthetic soil reinforcement shall possess minimum strength and durability required by design as determined by product specific testing as defined in the NCMA Design Manual for Segmental Retaining Walls (Section 3.5), including provisions for minimum partial safety factors. Design submittal shall indicate the index tensile strength for each reinforcement type to be used in construction.
  2. Geogrid:
    - a. Stratagrid by Strata Systems, Inc.
    - b. Nicolon/Mirafi
    - c. Tensar (UX/MSE Series Geogrids Only)
    - d. Approved equals.
- B. Steel Soil Reinforcement:
  - a. Only allowed if approved in advance by owner.

## 2.5 DRAINAGE MATERIALS

- A. Drainage collection pipe shall be perforated/slotted PVC pipe or perforated corrugated polyethylene (PE) pipe as specified in Section 33 40 00 or perforated clay pipe, ASTM C700, Standard- and Extra-Strength classes, unglazed, socket-and-spigot ends, for gasketed joints.
- B. The pipe shall be covered with a knitted or non-woven geotextile sock specifically designed to function as a filter.
- C. Drainage aggregate shall be free-draining material, relative to the surrounding soil conforming to the SRW manufacturer's recommendations in order to prevent build-up of hydrostatic pressure.
- D. Drainage Geotextile:



1. Geotex 401 by Synthetic Industries, Chattanooga, TN 37416, (423)553-2772.  
[http://www.fixsoil.com/index.php?sub=p4\\_nonwoven](http://www.fixsoil.com/index.php?sub=p4_nonwoven)
2. C-60NW by CONTECH Construction Products Inc., Middletown, OH 45044 (800) 338-1122.  
<http://www.contech-cpi.com/products/productGroups.asp?id=6>
3. 150EX by Linq Industrial Fabrics, Inc., Summerville, SC 29483, (843) 873-5800.  
<http://www.linq.com/geotex/geohome.html>

E. Drainage Composite:

1. J-DRain 400 Dimple Core Drainage Composite by JDR Enterprises, Inc., Alpharetta, GA, (800) 843-7569.
2. Mirafi G100N Drainage Composite by Mirafi Construction Products, Pendergrass, GA, (888) 795-0808.
3. Battle Drain I by Linq Industrial Fabrics, Inc., Summerville, SC. (800) 543-9966.

## 2.6 REINFORCED WALL BACKFILL

A. Reinforced soil shall possess the following characteristics:

1. Less than 35% passing the No. 200 sieve per ASTM D422 with a maximum size of 3/4 inches (4 inch maximum for steel reinforced systems).
2. A liquid limit < 40 and plasticity index < 10 per ASTM D4318.
3. An effective angle of internal friction > 30° per ASTM D2166 or D3080 at the compaction standard. Use of an effective friction angle greater than 30 degrees for design shall be verified by appropriate testing submitted to and approved by the owner's engineer prior to construction.
4. Less than 5% organic material.

B. Backfill reinforced with geosynthetic shall have a pH in the range of 3 to 9 per ASTM G51.

C. Backfill reinforced with steel reinforcement shall have a pH in the range of 5 to 10 per ASTM G51, minimum resistivity of 3000 ohm-cm at 100% saturation per ASTM G57 and free of sulfates > 200 ppm or chlorides > 100 ppm. If the resistivity is  $\geq$  5000 ohm-cm, the chloride and sulphate requirements are waived. Subject to approval, the owner's engineer may allow slightly wider ranges of pH for higher resistivities.

## 2.7 RETAINED BACKFILL OR COMMON BACKFILL

- A. Soil placed behind the reinforced backfill shall be satisfactory fill material as specified in Section 02 23 00.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Comply with federal, state and local requirements for execution of the work, including local building codes and current OSHA excavation regulations. Provide excavation support as required to maintain stability of the area during excavation and wall construction and to protect existing structures, utilities, landscape features, or property or improvements.
- B. Prior to grading or excavation of the site, confirm the location of the retaining walls and all underground features, including utility locations within the area of construction. Ensure surrounding structures are protected from effects of wall excavation.
- C. Coordinate installation of underground utilities and other improvements with wall installation.
- D. Control surface water drainage and prevent inundation of the retaining wall area during construction.

### 3.2 EXCAVATION

- A. Excavate to lines and grades shown on the Construction Drawings. Take precautions to minimize over-excavation. Over-excavation shall be backfilled with approved compacted material.
- B. Inspect excavation prior to placement of leveling pad material.
- C. In areas where soft, disturbed or otherwise unsuitable soils are encountered within the zone of the wall loading in the excavations, such unsuitable soils shall be over-excavated to the depths and extents required and replaced with select material and compacted per the contract documents.
- D. Fill over-excavated areas in front of wall face with approved compacted material before wall construction reaches 4 feet in height.
- E. In areas where a retaining wall or portion of a retaining wall is to be installed into cut, the required excavation shall extend horizontally to the extent of the reinforced zone and vertically to the elevation of the top of the leveling pad. The retained zone shall be bench cut in order to permit controlled placement of retained backfill.

### 3.3 LEVELING PAD CONSTRUCTION

- A. Place leveling pad as shown on the Construction Drawings with 6 inches of crushed dense aggregate base or 8 inches of lean concrete. The leveling pad shall extend laterally a minimum distance of 6 inches from the toe and heel of the lower-most SRW Unit in accordance with manufacturer's recommendations.
- B. Foundation soil shall be proofrolled and the top 12 inches compacted to minimum 95 % Standard Proctor Maximum Dry Density (ASTM D698) and tested prior to placement of leveling pad materials.
- C. Compact granular leveling pad material to provide a level hard surface on which to place the first course of units. Compact with mechanical plate compactors to minimum 95 % of Standard Proctor Maximum Dry Density (ASTM D698).

### 3.4 SRW UNIT INSTALLATION

- A. Place first course of SRW units on the leveling pad. Level units' side-to-side, front-to-rear and aligned with adjacent units.
- B. Ensure units are in full contact with base.
- C. Place the front of the unit's side-by-side without gaps between the fronts of adjacent units. Layout of curves and corners shall be in accordance with SRW manufacturer's installation guidelines.
- D. Install mechanical fascia connections per SRW manufacturer's recommendations.
- E. Place and compact unit drainage fill within, between, and behind units. Place and compact infill soil behind drainage fill. Mechanical vibrating plate compactors shall not be used on top of the units. Compact fill between units and the three-foot zone behind the units by running hand-operated compaction equipment just behind units. Compact to minimum 80 % Relative Density (ASTM D2949).
- F. Place core drainage fill in the previous course of units prior to stacking of subsequent segmental retaining wall units.
- G. Clean excess debris from top of units.
- H. Repeat procedure to the extent of wall height.

### 3.5 SOIL REINFORCEMENT INSTALLATION

- A. Soil reinforcement shall be oriented with the highest strength axis perpendicular to the wall alignment. Verify orientation (Roll direction) of geosynthetic reinforcement.
- B. Install soil reinforcement to wall height, horizontal location, and extent as shown on the Drawings.
- C. Lay the soil reinforcement horizontally on compacted backfill. Pull geogrid taut and connect to concrete SRW units according to connection detail shown on the Drawings or as recommended by manufacturer prior to backfill placement on geosynthetic reinforcement.
- D. Soil reinforcements shall be continuous throughout their embedment lengths. Spliced connections between shorter pieces will not be allowed.
- E. Do not operate tracked construction equipment directly upon soil reinforcement. Provide a minimum fill thickness of 6 inches prior to operation of tracked equipment over soil reinforcement. Keep tracked vehicle turning to minimum to prevent tracks from displacing the fill and damaging soil reinforcement.
- F. Rubber-tired equipment may pass over soil reinforcement at low speeds, less than 10 mph, if permitted by the manufacturer. Avoid sudden braking and sharp turning.
- G. Changes to soil reinforcement layout, including, but not limited to, length, soil reinforcement type (strength), or elevation, may be made subject to approval of the Engineer.

### 3.6 REINFORCED BACKFILL PLACEMENT

- A. Place reinforced backfill, spread and compact in such a manner that will not develop slack in the soil reinforcement in accordance with Manufacturer's recommendations.
- B. Place and compact reinforced backfill in lifts not to exceed 8 inches in compacted thickness.
- C. Compact reinforced backfill to a minimum of 95 % Standard Proctor Maximum Dry Density (ASTM D698) at a moisture content from 2 % below to 2 % above optimum.
- D. Compact reinforced backfill in all areas to the lines and grades shown on the Construction Drawings including all sloped areas above walls.
- E. At the end of each day's operation, slope the last lift of reinforced backfill away from the wall facing to rapidly direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

### 3.7 RETAINED BACKFILL PLACEMENT

- A. Retained backfill shall be placed in maximum 8-inch-thick compacted lifts and compacted to minimum 95 % Standard Proctor Maximum Dry Density (ASTM D698).

### 3.8 DRAINAGE SYSTEM

- A. Drainage Collection Pipe:
  1. Install the drainage collection pipe according to line, grades and sections shown on the Drawings.
- B. Drainage Aggregate:
  1. Install drainage aggregate to line, grades, and sections shown on the Drawings.
  2. When blanket drain is installed, non-woven geotextile shall be installed prior to aggregate placement in accordance with the Drawings.
- C. Drainage Composite:
  1. Install drainage composite as shown on the Drawings.
  2. Wrap upper ends of drainage composite with approved geotextile fabric.

### 3.9 SRW CAP INSTALLATION

- A. Place SRW Cap units per manufacturer's recommendations. Backfill and compact to finished grade.
- B. Incorporate surface water drainage control (swale) into finished grading at top of wall, as shown on the Drawings.
- C. Attach cap units to wall units with construction epoxy. Apply epoxy to bottom surface of cap unit and install on clean units below. Follow epoxy manufacturer's directions to ensure permanent bond.

### 3.10 CONSTRUCTION

- A. SRW Tolerances: Installation of SRW face location shall be within all the following tolerances:
  - 1. Vertical control from plan:  $\pm 1.25$  inches over a 10 ft. distance.
  - 2. Horizontal location control from plan:
    - a. Straight lines:  $\pm 1.25$  inches over a 10 ft. distance.
    - b. Straight & radius corner locations:  $\pm 1.0$  ft.
    - c. Curves and serpentine radius:  $\pm 2.0$  ft.
  - 3. Rotation of the wall face during construction:
    - a. Maximum 2.0 degrees from established wall plan batter.
    - b. Maximum,  $\pm 10.0$  % from total established horizontal setback.
  - 4. Bulging:  $\pm 1.25$  inches over a 10.0 ft. distance.
- B. Mechanical vibrating plate compactors shall not be used on top of the units. Compact fill between units and the backfill zone behind the units by running hand-operated compaction equipment just behind units. Perform compaction to manufacturer's recommendations.

### 3.11 FIELD QUALITY CONTROL

- A. Responsibilities: Unless otherwise specified, the quality control tests and inspections specified below will be conducted by the Owner's Construction Testing Laboratory (CTL) at no cost to the Contractor in accordance with Section 31 10 00. The Contractor shall perform additional testing or inspection as considered necessary by the Contractor for assurance of quality control. Field testing, frequency, and methods may vary as determined by and between the Owner and CTL.
- B. Work shall be performed by a Special Inspector – Technical II unless specified otherwise.
- C. Submit test reports in accordance with Section 31 10 00.
- D. Segmental Retaining Wall Units:
  - 1. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C140 with the following exceptions:
    - a. Coupon shall have a minimum thickness of 1-1/2 inches.
    - b. Coupon shall not be oven dried before testing.
  - 2. The compressive strength shall be considered the average of three or more test coupons.
  - 3. Run compressive strength testing for every 7,500 square feet of installed wall facing material or fraction thereof. The testing shall be performed immediately upon receipt from laboratory.
- E. Soil and Backfill Testing: Unless otherwise directed by the Owner or required by this technical scope of work, type and minimum frequency of testing for soils-related portions of construction shall be as follows.
  - 1. Field density tests in accordance with ASTM D2922:
    - a. Subgrade Soils: One test for every 2,500 square feet per lift of material.
    - b. Base Leveling Pad: One test for every 100 lineal feet.
    - c. Reinforced Backfill: One test for every 2,500 square feet per lift. Every other lift shall be tested.

2. Laboratory moisture-density relationships, ASTM D698: One test for every compacted material type.
3. Gradation Analysis, ASTM D422:
  - a. Unit Fill: One test for every 500 cubic yards of material.
  - b. Reinforced Backfill: One test for every 500 cubic yards of material or when material type changes.

**END OF SECTION 32 32 23**

## **SECTION 32 40 00 - TRAFFIC SIGNS**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes
  - 1. Traffic control signs.

#### 1.2 REFERENCES

- A. American Standard for Testing Materials (ASTM)
  - 1. ASTM C94 - Ready Mix Concrete
- B. US Department of Transportation, Federal Highway Administration
  - 1. Manual on Uniform Traffic Control Devices (MUTCD).

### **PART 2 - PRODUCTS**

#### 2.1 SIGNS: Conform to the following and MUTCD classification is shown in parentheses:

- A. "STOP" Signs: 30-inches x 30-inches, Octagon, white legend and border on red background (R1-1)
- B. "DO NOT ENTER" Signs: 30-inches x 30-inches, white legend, bar, and background and red circle (R5-1)
- C. "ACCESSIBLE PARKING SYMBOL" Signs: 12-inches x 18-inches, green legend and border, white symbol on blue box, and white background (R7-8)
- D. Miscellaneous Signs: See Construction Drawings

#### 2.2 POSTS

- A. "U" channel galvanized steel posts with galvanized sign-mounting hardware for each sign. Posts shall have a weight of 2-pounds per lineal foot.

#### 2.3 CONCRETE

- A. Mix concrete and deliver in accordance with ASTM C94.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:
  - 1. Compressive Strength: 4,000 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
  - 2. Slump Range: 1 to 3-inches at time of placement
  - 3. Air Entrainment: 6.5 percent, plus or minus 1.5 percent

### **PART 3 - EXECUTION**

#### 3.1 PREPARATION

- A. Contractor shall field verify underground utilities prior to sign installation. Primary utilities of concern of shallow depths are lawn sprinkler systems, electric, telephone, fiber optic, cable and gas.
- B. Cost related to repair of damaged surface and subsurface facilities shall be paid for by the Contractor at no additional expense to the Owner.

3.2 INSTALLATION

- A. Install posts in 18-inch diameter x 24 inch deep concrete foundations. Set posts vertical and plumb with bottom of sign at minimum 7'-0" above finish grade unless otherwise indicated on the Construction Drawings. Mount signs in accordance with manufacturer's instructions.

**END OF SECTION 32 40 00**

**SECTION 329200 – TURF AND GRASSES**

**1. GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
  - 1. See Section 00 73 00 “Supplementary Conditions”, if included, for requirements relating to interpretation of the drawings and specifications.

**1.2 SUMMARY OF WORK**

- A. Work shall include all labor, materials, and equipment necessary to completely furnish and install the Turf and Grasses as indicated on the plans and as herein specified.
- B. This section includes the following:
  - 1. Seeding
  - 2. Hydroseeding
  - 3. Sodding
  - 4. Meadow grasses and wildflowers
  - 5. Turf renovation
- C. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 31 Section “Erosion and Sediment Control Systems” for erosion control materials
  - 2. Division 31 Section “Earthwork” for excavation, filling and backfilling, and rough grading
  - 3. Division 32 Section “Plant Material” for border edg ings

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
  - 1. Pesticides and Herbicides: Include product label and manufacturer’s application instruction specific to this project.
- B. Certification of Grass Seed: From seed vender for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Included year of production and date of packaging.
  - 1. Certification of each seed mixture for turf grass sod and seed. Include identification of source, name and telephone number of supplier.



- C. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of manicured turf grass and native meadow grass during a calendar year. Submit before expiration of required initial maintenance periods.
- D. Qualification Data: For qualified landscape Installer.
- E. Material Test Reports: For existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil.
- F. Product Certificates: For fertilizers from manufacturer.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landscaper Network or the American Nursery and Landscape Association
  - 2. Experience: Five (5) years' experience in turf installation
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress
  - 4. Pesticide Applicator: State licensed, commercial.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened container showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver Sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge or soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery or bulk fertilizer and soil amendments with appropriate certificates.

#### 1.6 PROJECT CONDITIONS

- A. Proceed with and complete seeding work as rapidly as portions of site become available, working within seasonal limitations.

- B. Protect existing utilities, paving, plant material, and other facilities from damage caused by seeding operations.
- C. Perform seeding work only after planting and other work affecting ground surface has been completed.
- D. Restrict pedestrian, bicycle, vehicular and other traffic from lawn areas until grass is established. Erect signs and barriers as required.
- E. Provide hose and lawn watering equipment as required.
- F. Planting Restrictions: Plant during on of the following periods.
  - 1. Spring Planting: May 15-June 30 for cool and warm season grasses.
  - 2. Fall planting: September 1-October 15 for cool season grasses only and dormant planting is to be November 1-December 15. Seeding operations shall occur immediately after preparation of bed during this season only, except when prior written permission is obtained from the Architect.
  - 3. Weather Limitations: The actual planting shall be performed during those times in this season which are normal for such work as determined by weather conditions, and accepted practice in the locality. No work shall be performed when the ground is frozen, wet or otherwise un-tillable or when even distribution of materials cannot be obtained.

#### 1.7 MAINTENANCE SERVICE

- 1. Initial Turf Maintenance Service: Provide full maintenance for 1 year by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established.

## 2. PRODUCTS

### 2.1 SEED

- A. Grass Seed: Fresh, clean, dry and new crop complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances. Provide seed mixture composed of grass species, proportions and minimum percentages of purity and germination. Noxious weed seed free.
- B. Seed Mixture types: As noted on drawings.

### 2.2 TURFGRASS SOD

- A. Turfgrass Sod: Approved, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Sod Mixture types: As noted on drawings.

### 2.3 MEADOW GRASSES AND WILDFLOWERS

- A. Wildflower Seed: Fresh, Clean, and dry new seed, of mixed species as indicated on drawings

- B. Native Grass Seed: Fresh, Clean, and dry new seed, of mixed species as indicated on drawings
- C. Wildflower and Native Grass Seed: Fresh, Clean, and dry new seed, of mixed species as indicated on drawings
- D. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

#### 2.4 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast-and slow-release nitrogen, 50 percent derived from natural organic sources or urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil report from a qualified soil-testing laboratory.

#### 2.5 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew-and seed free, salt hay or threshed strew of wheat, rye, oats, or barley.

- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacture for slurry application; nontoxic and free of plant-growth or germination inhibitors.

## 2.6 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

## 2.7 WATER

- A. Water: Free of substance harmful to seed growth. Hoses or other methods of transportation furnished by Contractor.

## 3. EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
  - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches . Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
  - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
  - 2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
  - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
  - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate as noted on drawings
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes where shown on Drawings; installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:3 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons /acre to form a continuous blanket 1 inch in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

### 3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with manufacturer's recommended tackifier.
  - 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
  - 3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

### 3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across angle of slopes exceeding 1:3.
  - 2. Anchor sod on slopes exceeding 1:4 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.7 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 2 inch per week unless rainfall precipitation is adequate.
- C. Mow manicured turf grasses as soon as top growth is tall enough to cut. Repeat mowing to maintain a min 2.5 inch to 3 inch height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

### 3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
  - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

### 3.9 MEADOW GRASSES AND WILDFLOWERS

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at a total rate as indicated on drawings.
- C. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.
- D. Water newly planted areas and keep moist until meadow is established.

### 3.10 MEADOW GRASSES AND WILDFLOWER MAINTENANCE

- A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water meadow with fine spray at a minimum rate of 1 inch per week for six weeks after planting unless rainfall precipitation is adequate.



3.11 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

## SECTION 32 93 00 – PLANT MATERIALS

### 1. GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
  - 1. See Section 00 73 00 “Supplementary Conditions”, if included, for requirements relating to interpretation of the drawings and specifications.

#### 1.2 SUMMARY OF WORK

- A. Work shall include all labor, materials, and equipment necessary to completely furnish and install the Plant Materials as indicated on the plans and as herein specified.
- B. The section includes the following:
  - 1. Plant Materials as indicated on drawings
- C. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 31 Section “Earthwork” for excavation, filling, and grading.
  - 2. Division 31 Section “Erosion and Sediment Control Systems” for erosion control materials
  - 3. Division 31 Section “Finish Grading” for finish grade requirements
  - 4. Division 32 Section “Turf and Grasses”.
- D. Nomenclature used conforms to the standard nomenclature as published in Hortus III, 1976. Names of varieties not listed conform generally with names accepted by the nursery trade.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant material
    - a. List of Sources: Submit a written list of the nurseries where the plant material was grown. Plant materials from unapproved sources will be rejected.
  - 2. Pesticides and Herbicides: Include product label and manufacturer’s application instruction specific to the Project
- B. Samples for Verification: For each of the following
  - 1. Trees and Shrubs: Samples of each variety and size delivered to the site for review

2. Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture and organic makeup.
- C. Qualification Data: For qualified landscape installer. Included list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, address, and year completed, and include name and addresses of owners' contact persons.
  1. Provide copy of Professional Landcare Network or the American Nursery and Landscape Association membership.
- D. Certificate of Inspection: Submit certificates of inspection as required by governmental authorities.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.
- F. Maintenance Inspection Reports: Provide dates and location of plant material replaced during the special project warranty.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants
  1. Professional Membership: Installer shall be a member in good standing or either the Professional Landcare Network or the American Nursery and Landscape Association
  2. Experience: 5 years' minimum experience in landscape installation.
  3. Installer's Field Supervision: Require Installer to maintain an experienced full-term supervisor on Project site when work is in progress
  4. Pesticide Applicator: State licensed, commercial
- B. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site
  1. Notify Landscape Architect or sources of planting materials 7 days in advance of delivery to site
- C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Deciduous Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger trees.
    - a. Evergreen Trees: Height measurement shall not be taken at the tip of the leader, but should be taken at the midpoint between the uppermost whorl(s) and the tip of the leader.
  2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- E. Preinstallation Conference: Conduct conference at Project site with owner and landscape architect.
- 1.5 DELIVERY, STORAGE AND HANDLING
- A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery and while stored at site. All plants shall be packed in such a manner as to assure proper protection against freezing, drying, breaking, overheating or other injury. Use accepted practices to insure arrival in good condition.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements including pervious concrete unit pavement, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge or soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Deliver trees and shrubs after preparations for planting have been completed. Plant immediately. If planting is delayed more than 6 hours after delivery, set trees and shrubs in shade, protect from damage, and keep roots moist by covering with mulch, burlap or other acceptable means of retaining moisture.
1. Set balled stock on ground and cover ball with soil, peat moss or other acceptable material.
  2. Do not remove container-grown stock from container before time of planting.
  3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.6 PROJECT CONDITIONS

- A. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.
- B. Planting Restrictions: Plant materials only during normal planting seasons for each type of landscape work required, except when prior written permission is obtained from the Architect. Actual planting time shall be as determined by weather conditions and accepted local practice. The planting seasons shall be:
  - 1. Fall Planting Season: From August 15 to September 15 for all coniferous materials and from October 15 to November 15 for all deciduous materials; perennials shall be planted from September 1 to October 1.
  - 2. Spring Planting Season: From March 15 to May 1 for all coniferous materials and from March 1 to May 15 for all deciduous materials; perennials shall be planted from April 15 to May 31.

- C. Coordination with Lawns and Irrigation Systems: Planting of plant materials shall be after establishment of final grades and prior to planting of lawns and installation of irrigation system, unless otherwise acceptable to Architect.
  - 1. If planting of plant materials occurs after lawn work, protect lawn areas and irrigation system and promptly repair damage resulting from planting operations.

1.7 SPECIAL PROJECT WARRANTY

- A. The Contractor shall provide replacement plants for all plant materials which die during the 1 year of establishment following the completion and acceptance of all plantings.
  - 1. Failures include, but are not limited to, the following:
    - a. Death or unsatisfactory growth, except for defects resulting from abuse, or material damaged by vandalism or unusual phenomena or incidents beyond the Landscape Installer's control will not be replaced as part of this contract.
    - b. Structural failures including plantings falling from blowing over
    - c. Faulty performance of tree stabilization
  - 2. Include the following remedial actions as a minimum:
    - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period
    - c. Provide extended warranty for period equal to original warranty period, for replaced plant material.
- B. Establishment Period: will not begin until all of the following items of work have been performed. All plant material shall be in acceptable growing condition when the project enters the establishment period.
  - 1. Notify Architect for inspection and acceptance.
  - 2. Planting
  - 3. Backfilling
  - 4. Watering
  - 5. Pruning
  - 6. Wrapping
  - 7. Staking
  - 8. Guying
  - 9. Mulching

- C. Completion of the Establishment Period: Landscape Architect will make an inspection of the plant material for acceptability. The Contractor will be notified in writing of the quantities of the plant material that shall be replaced in the next planting season.
  - 1. Replacement plants shall be at the Contractor's expense. Plant material damaged by vandalism or unusual phenomena or incidents beyond the Landscape Installer's control will not be replaced as part of this contract.
- D. The Contractor's responsibility for all spring replacement plants shall extend for 60 days after such time as the last plant to be replaced is properly planted and accepted by the Landscape Architect. The Contractor's responsibility for all fall replacement plants shall extend until June 1 of the following year.

## 1.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees, Shrubs, Groundcovers and all other plants: Provide maintenance by skilled employees and landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below
  - 1. Maintenance Period: 1 year from date of substantial completion

## 2. PRODUCTS

### 2.1 PLANT MATERIALS

- A. Provide trees, shrubs, and other plants of size, genus, species, and variety shown and scheduled. Comply with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock," latest edition.
- B. Provide plant materials grown under climatic conditions similar to conditions in Macon, Missouri (USDA Zone 6, Arnold Arboretum Zone 4) for a minimum of two years.
- C. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system. Provide ball sizes complying with the latest edition of ANSI Z60.1 "American Standard for Nursery Stock." Cracked or mushroomed balls are not acceptable.
- D. Furnish minimum size indicated. Larger stock is acceptable provided stocks will not be cut back to size indicated. Enlarge root ball in proportion to the size of the plant.
- E. No pruning wounds shall be present with a diameter of more than 1" and such wounds must show vigorous bark on all edges.

- F. Deciduous Trees: Provide balled and burlapped (B & B) trees of height and caliper as indicated with branching configuration recommended by ANSI Z60.1 for type and species required. Unless otherwise indicated, provide single stem trees.
- G. Deciduous Shrubs: Provide balled and burlapped or container grown shrubs of the height indicated and with not less than minimum number of canes required by ANSI Z60.1 for type and height of shrub required. Thin plants will not be accepted. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other injuries.
- H. Coniferous Evergreens: Provide balled and burlapped (B & B) evergreens of sizes indicated. Dimensions indicate minimum spread and height. Provide normal quality evergreens with well-balanced form, branched to the ground. Shearing evergreens will be cause for rejection.
- I. Perennials: Provide container grown perennials which exhibit well-developed root systems and healthy, well-developed crowns.

2.2 MISCELLANEOUS PLANTING MATERIALS

- A. Topsoil for Shrub Planting Areas: Fertile, friable, natural loam, dark in color (often black), free of subsoil, clay lumps, brush, weeds, roots, stumps, stones larger than 1-1/2" in any dimensions, debris, and other extraneous or toxic matter and harmful to plant growth. Topsoil shall be obtained from local sources and exhibit an acidity range (pH) of 7.0 to 8.0. Identify location of source.
- B. Mulch for Trees, Shrubs and Perennials: Organic mulch, free from wood chips, sawdust and deleterious materials, suitable for top dressing of trees. Mulch shall consist of six-month-old, well-rotted, shredded native hardwood bark mulch not larger than 4" in length and 1/2" in width.
- C. Fertilizer: Provide commercial type fertilizer of neutral character approved by Architect, containing 12% nitrogen, 4% phosphoric acid and 8% potash by weight. Application rates shall be as follows:
  - 1. For 1 1/2" Caliper Trees: 3/4 pound per plant
  - 2. For 2 1/2" Caliper Trees: 1-1/4 pound per plant
  - 3. For 6' B&B Trees: 1/2 pound per plant
  - 4. For No. 5 Container shrubs: 1/3 pound per plant
  - 5. For No. 6 Container shrubs: 1/4 pound per plant
- D. Anti-Desiccant: Emulsion type, film-forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.
- E. Plant Starter: Liquid solution with an analysis of 3-10-3 (low analysis fertilizer), such as Upstart manufactured by Ortho, or approved equal. Guaranteed analysis shall be as follows:
 

1. Total Nitrogen (N)	3.00%
2. Ammoniacal Nitrogen	2.10%
3. Nitrate Nitrogen	0.90%
4. Available Phosphoric Acid (P <sub>2</sub> O <sub>5</sub> )	10.00%
5. Soluble Potash (K <sub>2</sub> O)	3.00%



- 6. Nutrients from Ammonium Phosphate and Nitrate of Potash Chloride  
Not more than 0.10%
- 7. Thiamine Hydrochloride (Vitamin B-1) 0.01%
  
- F. Wrapping: Tree wrap shall be designed to prevent bore damage and winter freezing and shall consist of two sheets of crinkled, waterproof paper, cemented together with asphalt, and weighing not less than 4 pounds per 100 square feet. Tree-wrap tape shall be not less than 4" wide.
  
- G. Twine: Two-ply jute material.
  
- H. Water: Free of substances harmful to plant growth. Hoses shall be furnished by Contractor.
  
- I. Stakes: Stakes shall be hardwood 2" x 2" by height indicated.
  
- J. Guying Hose: Two-ply, reinforced garden hose not less than 1/2" inside diameter.
  
- K. Guying Wire: 12 gauge galvanized double-twisted wire.
  
- L. Edging: If and where indicated on the drawings, provide 3/16" x 4" mil finish continuous aluminum edging equal to Permalock Clean Line Aluminum edging (800) 356-9660.

**3. EXECUTION**

**3.1 PREPARATION**

- A. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.
  
- B. Layout individual tree and shrub locations. Stake locations and secure Architect's acceptance before start of planting work. Make minor adjustments as may be requested.
  
- C. Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required.
  
- D. Excavate pits, beds and trenches with vertical sides and with bottom slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation and scarify sides.
  - 1. For balled and burlapped trees and shrubs, scarify bottom of the excavations to a depth of 4". Make excavations equal to the depth of ball, and diameter at least 12" greater than ball for shrubs and 24" trees.

- E. When conditions detrimental to plant growth are encountered, such as rubble fill or adverse drainage conditions, notify Architect. Hand excavate near underground utilities. Maintain grade stakes set by others until removal is agreed upon by all parties concerned.
- F. Place new topsoil in all planting beds to a depth of 12 inches prior to planting.

### 3.2 PLANTING TREES AND SHRUBS

- A. Planting shall be performed only by experienced persons familiar with planting procedures under the supervision of a qualified supervisor.
- B. Set balled and burlapped stock plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Rotate plants to give the best appearance and relationship to each other or adjacent structures.
- C. For all plants other than evergreens, remove burlap from sides of balls but retain burlap on bottoms. Where wire basket used, cut and remove wire basket without disturbing plant roots. Completely remove containers for container grown stock.
- D. Place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Apply plant starter at manufacturer's suggested rates during watering process. Water again after placing final layer of backfill. Remove all ropes and wires from tops of balls. Dish top of backfill to allow for mulching.
- E. Mulch plant pits. Provide not less than 3" thickness of mulch and work into top of backfill and finish level with adjacent finish grades. Mulch within 24 hours of planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.
- F. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage.
  - 1. If deciduous trees or shrubs are moved during full-leaf period, spray with anti-desiccant at nursery prior to moving and again two weeks after planting.
- G. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by Architect, do not cut tree leaders and remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character. Prune evergreens only to remove broken or damaged branches.
- H. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

- I. Wrap tree trunks of 3/4" caliper and larger. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures before wrapping. Start at ground and cover trunk to height of first branches and securely attach. The overlap shall not be less than 1/3 the width of the tree wrap. The wrapping shall be securely fastened with tree-wrap at top, middle and bottom. Stapling and the use of nylon reinforced strapping tape are not approved fastening methods.

### 3.3 MAINTENANCE

- A. Begin maintenance immediately after planting. Maintain trees, shrubs and other plants until final acceptance of the entire project.
- B. Maintain trees, shrubs and other plants by pruning, cultivating and weeding as required for healthy growth. Restore planting saucers. Tighten and repair stake and guy supports and reset trees to proper grades or vertical position as required. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease. Water trees and shrubs not less than twice per week until final acceptance.

### 3.4 CLEANUP AND PROTECTION

- A. During landscape work, keep pavements clean and work areas in an orderly condition.
- B. At completion of establishment period the Contractor shall remove all stakes, guy wires, and rubber hose guards and dispose of materials off-site.

END OF SECTION 32 93 00

## **SECTION 33 10 00 - WATER DISTRIBUTION**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes
  1. Site water piping and fittings including domestic potable waterline and fire protection system supply waterline, valves, and fire hydrants.
- B. Related Sections
  1. Section 31 10 00 – Earthwork

#### **1.2 REFERENCES**

- A. American Society of Mechanical Engineers (ASME)
  1. ASME B 16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- B. American Society for Testing and Materials (ASTM)
  1. ASTM B88 - Seamless Copper Water Tube
  2. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
  3. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
  4. ASTM D2564 - Poly (Vinyl Chloride) (PVC) Solvent Cement
  5. ASTM D2672 - Poly (Vinyl Chloride) (PVC) Integrally Molded Bell Ends For Solvent - Cemented Pipe Joints.
  6. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
  7. ASTM F477 - Elastomeric Gaskets and Lubricant
  8. ASTM F656 - Poly (Vinyl Chloride) (PVC) Cement Primer
- C. American Water Works Association (AWWA)
  1. AWWA C105 – Polyethylene Encasement for Ductile Iron Piping for Water and other Liquids
  2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches, for Water and Other Liquids
  3. AWWA C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
  4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
  5. AWWA C500 - Gate Valves for Water and Sewage Systems
  6. AWWA C504 - Rubber-Seated Butterfly Valves
  7. AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances
  8. AWWA C651 - Disinfecting Water Mains
  9. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution
- D. National Fire Protection Associations (NFPA)
  1. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- E. Local Governing Authority / Utility Company Requirements
  1. Follow all requirements of local governing authority and/or utility company.

#### **1.3 QUALITY ASSURANCE**

- A. Products, where marked for compliance with code or test standards, shall also mark specific standard as required in the Contract Documents.
- B. Perform installation in accordance with utility company or municipality requirements.

- C. Valves: Mark manufacturer's name and pressure rating on valve body.
- D. Perform disinfection of potable lines in accordance with AWWA C651.

#### 1.4 SUBMITTALS

- A. Product Data: Provide Project Engineer with data on pipe materials, pipe fittings, hydrants, valves, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
- C. Furnish 1 copy of results of meter test and hydrostatic pressure test to Owner and utility company upon completion of water distribution backfilling operations.
- D. Project Record Documents:
  - 1. Disinfection report: Record the following:
    - a. Type and form of disinfectant used.
    - b. Date and time disinfectant injection start and time of completion.
    - c. Test locations.
    - d. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
    - e. Date and time of flushing start and completion.
    - f. Disinfectant residual after flushing in ppm for each outlet tested.
  - 2. Bacteriological report: Record the following:
    - a. Date issued, project name, testing laboratory name, address, and telephone number.
    - b. Time and date of water sample collection.
    - c. Name of person collecting samples.
    - d. Test locations
    - e. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
    - f. Coliform bacteria test results for each outlet tested.
    - g. Certification that water conforms, or fails to conform, to bacterial standards.
    - h. Bacteriologist's signature and authority.
  - 3. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
  - 4. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

## PART 2 - PRODUCTS

### 2.1 PIPE

- A. Pipe sizes less than 3-inches that are installed below grade and outside building shall comply with the following:
  - 1. Seamless Copper Tubing: Type "K" soft copper, ASTM B88.
  - 2. Fittings: Wrought copper (95-5 Tin Antimony solder joint), ASME B 16.22.
    - a.
- B. Pipe sizes 3-inches and larger that are installed below grade and outside building shall comply with one or combination of following:
  - 1. Gray Cast Iron Water Pipe: ANSI A21.6, thickness class 52.
    - a. Fittings: Either mechanical joint or push-on joint, AWWA C110 or AWWA C111.
    - b. Elastomeric gaskets and lubricant: ASTM F477.
  - 2. Ductile Iron Water Pipe: AWWA C151, thickness class 50.
    - a. Fittings: Either mechanical joint or push-on joint, AWWA C110 or AWWA C111.
    - b. Elastomeric gaskets and lubricant: ASTM F477.

3. Polyvinyl Chloride (PVC) Water Pipe: Pipe, AWWA C900, rated DR 18 (Class 150), continually marked as required.
  - a. Elastomeric gaskets and lubricant: ASTM F477 for smaller pipes.
  - b. Pipe joints: Integrally molded bell ends, ASTM D3139.
  - c. Trace wire: Magnetic detectable conductor, (#12 Copper) brightly colored plastic covering imprinted with "Water Service" in large letters.

2.2 VALVES

- A. Gate Valves, 2-Inches and Larger:
  1. Manufacturer and Model: Mueller Resilient Wedge Gate Valves or approved equal.
  2. AWWA C500, Iron body, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, post indicator were indicated on Construction Drawings, extension box and valve key.
- B. Ball Valves, 2-Inches and Smaller:
  1. Manufacturer and Model: Mueller Oriseal or approved equal.
  2. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.
- C. Butterfly Valves, From 2-Inch to 24-Inch: AWWA C504, Iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.
- D. Check Valves, Post Indicator Valves, And Backflow Preventors
  1. Refer to Fire Suppression in Architectural/Building Specifications

2.3 FIRE HYDRANTS

- A. Fire Hydrants: Type as required by utility company/Local Fire Department and as shown on Construction Drawings.
- B. Hydrant Extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
- C. Hose and Steamer Connections: Match sizes with utility company, with two hose nozzles, one pumper nozzle.
- D. Finish: Apply primer and 2 coats of enamel or special coating to color as required by utility company.

2.4 ACCESSORIES

- A. Thrust Blocking: Place 3000 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading undisturbed soil in excess of 2,500 pounds per square foot when water main pressure is 100 psi.

**MINIMUM THRUST BLOCKING BEARING AREAS**

Pipe Diameter	Tees	90° Bend Sq. Ft	45° Bend Sq. Ft	22½° Bend Sq. Ft.	11¼° Bend Sq. Ft.	5 5/8 Bend Sq. Ft.	Cap/Plug Sq. Ft.
3"	1.0	1.0	1.0	1.0	1.0	1.0	1.5
4"	1.0	1.0	1.0	1.0	1.0	1.0	2.0
6"	1.5	2.0	1.0	1.0	1.0	1.0	3.0
8"	2.5	3.5	1.8	1.0	1.0	1.0	4.0
10"	4.0	5.5	2.8	1.5	1.0	1.0	6.0
12"	6.0	8.0	4.0	2.0	1.5	1.0	8.5
14"	8.0	11.0	5.5	3.0	2.0	1.5	12.0

16"	10.0	14.2	7.0	4.0	3.0	2.5	15.0
18"	21.0	21.0	12.0	6.0	4.0	3.5	24.0

- B. Locked mechanical joint fittings shall be installed where vertical changes in direction are required and, if approved by Owner and governing authority, can be installed in lieu of above thrust blocking requirements.
- C. Polyethylene Encasement: Single layer of two-ply cross-laminated high density polyethylene encasement per AWWA C105, meeting the following nominal specifications; AWWA C105-93, Section 4.1.2, High Density Cross-Laminated Polyethylene Film, Type III, Class C (Black), Grade 33, tensile strength 5,000 psi minimum, elongation 100 percent, thickness nominal 0.004 inch (4 mil).

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that building service connection and municipal utility water main size, location, and depth are as indicated on Construction Drawings.

#### **3.2 PREPARATION**

- A. Ream pipe and tube ends and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe for connections to equipment with flanges or unions.
- D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

#### **3.3 TRENCHING AND BEDDING**

- A. Excavate pipe trench and place bedding material in accordance with Section 31 10 00.

#### **3.4 INSTALLATION - PIPE AND FITTINGS**

- A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
- B. Install pipe and fittings in accordance with AWWA C600.
- C. Ductile iron pipe and fittings shall be installed with polyethylene tubing around the pipe for the entire length of the project except where water main is within steel casing or is concrete encased. Install polyethylene tubing in accordance with AWWA C105, Method A.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
- E. Install access fittings in accordance with local codes to permit disinfection of water system performed under this Section.
- F. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions with least interference with operation of existing pipeline and in compliance with local utility company.

- G. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
- H. Place pipe to depth in accordance with Section 31 10 00.
- I. Backfill trench in accordance with Section 31 10 00.
- J. Install trace wire continuous over top of non-metal pipe. Bury trace wire along top of new pipe. Bring trace wire to surface at lid of all valve boxes and/or terminate at ductile iron pipe by wrapping a minimum of 5 loops around all ductile iron pipes before terminating trace wire.

### 3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Install gate valves as indicated on Construction Drawings. Support valve on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
- B. Install fire hydrant assemblies as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete blocking. Place minimum of 6-cubic feet of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Maintain vertical position of hydrant backfilling and compacting.

### 3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect distribution system with chlorine before acceptance for domestic operation. Chlorine dosage shall be not less than 50 parts per million. Flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours. Flush with clean water after contact period until residual chlorine content is not greater than 1.0 part per million. Flush water discharged from water supply lines or hydrants shall not be allowed to discharge directly onto exposed soil or turf, which could result in erosion of soil. If potential for erosion exists at discharge point, measures shall be taken to prevent erosion. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriological test in accordance with AWWA C651. Do not place distribution system in service until approval is obtained from local governing authorities.
- B. Contractor shall provide a means of neutralizing the super-chlorinated water before releasing into the environment. This may be accomplished by either a method of dichlorination, direct release into a detention area approved by Owner, or any method acceptable to federal, state, and local codes. Direct release to open ground shall not be allowed, unless contained within an on-site detention facility with 6" permanent storage. In this case, the Contractor shall time the release to assure that no rainstorms are imminent. The intent of this condition is to allow the majority of the chlorine to evaporate into the atmosphere before a rainstorm has the opportunity to wash the residual downstream. Contractor shall not release super-chlorinated water directly into the sanitary sewer system, private or public, nor any storm drain system not directly discharging into the detention facility.

### 3.7 SERVICE CONNECTIONS

- A. Provide water service connection in compliance with utility company requirements including reduced pressure backflow preventor (if required) and water meter with by-pass valves and sand strainer.

### 3.8 FIELD QUALITY CONTROL

- A. Test water distribution system pipe installed below grade and outside building in accordance with the following procedures:



1. Perform testing of pipe materials, joints, and other materials incorporated into construction of water mains and force mains to determine leakage and water tightness. Test pressure pipeline in accordance with Section 4 of AWWA C600 and NFPA 24. In the event state or local code requires more stringent test, more stringent test shall take precedence.
2. Pressure Test: After pipe has been laid, subject newly laid pipe or valved section to hydrostatic pressure of at least 1.5 times working pressure at point of testing and not less than 1.25 times working pressure at highest point along test section.
3. Leakage Test: Conduct leakage test concurrently with pressure test. Leakage is defined as quantity of water that must be supplied into newly laid pipeline or valved section thereof to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipeline has been filled with water. Leakage shall not be measured by drop in pressure in test section over period of time.

a. Leakage shall not be greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133200}$$

Where:

- L = allowable leakage, (gallons per hour)
- S = length of pipe tested, (feet)
- D = nominal diameter of pipe, (inches)
- P = average test pressure during test, (psig)

4. Visible Leakage: Repair visible leaks regardless of amount of leakage measured.
5. Acceptance of Installation: If test of pipe laid in place discloses leakage greater than that specified, Contractor shall, at his own expense, locate leak and make repairs as necessary until leakage is within specified allowance. Supply water for testing at no expense to Owner.

**END SECTION 33 10 00**

## **SECTION 33 20 00 - SANITARY SEWERAGE**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes
  1. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
  2. Connection of site sanitary sewer system to municipal sanitary sewer systems.
- B. Related Sections
  1. Section 31 10 00 – Earthwork: Trenching, backfill, and compaction for utilities

#### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  1. ASTM A74 - Cast Iron Soil Pipe and Fittings
  2. ASTM A746 - Ductile Iron Gravity Sewer Pipe
  3. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings
  4. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  5. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
  6. ASTM D2241 - Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
  7. ASTM D2657 - Heat-Joining Polyolefin pipe and Fittings
  8. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  9. ASTM D3035 - Polyethylene (PE) Plastic Pipe Using Flexible Elastomeric Seals
  10. ASTM D3139 - Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals
  11. ASTM D3261 - Butt Heat Fusion Polyethylene (PE) Plastic Fittings For Polyethylene Plastic Pipe And Tubing
  12. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  13. ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.
- B. American Water Works Association (AWWA)
  1. AWWA C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
  2. AWWA C600 - Ductile-Iron Water Mains and Their Appurtenances
  3. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In, For Water Distribution
  4. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing and Fittings 1/2 Inch Through 3 Inches, For Water Distribution
  5. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 Inch Through 63 Inch, For Water Distribution

#### 1.3 SUBMITTALS

- A. Product Data: Provide data of pipe materials, pipe fittings, and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified or local requirements.
- C. Project Record Documents:
  1. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations.
  2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

#### 1.4 PROJECT CONDITIONS

- A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

## **PART 2 - PRODUCTS**

### **2.1 SEWER PIPE, FITTINGS, AND JOINTS**

- A. Polyvinyl Chloride Pipe (PVC): ASTM D 3034, rated SDR 35 for pipes less than 12 feet deep and rated SDR 26 for pipes 12 feet to 20 feet deep. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
  1. Pipe joints: Integrally molded bell ends, ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

### **2.2 PIPE ACCESSORIES**

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.

### **2.3 CLEANOUTS**

- A. Shaft Construction: Cast iron shaft of internal diameter as specified on Construction Drawings with 2500 psi concrete collar for cleanouts.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that trench cut, and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

### **3.2 PREPARATION**

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

### **3.3 BEDDING**

- A. Excavate trench and place bedding material in accordance with Section 31 10 00.

### **3.4 INSTALLATION - PIPE**

- A. Install type and class of pipe as shown on the drawings. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manhole risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall be inspected for defects and cracks before being lowered into the trench. Defective, damaged, or unsound pipe, or pipe that has had its grade disturbed after laying shall be taken up and replaced. Commence installation at lowest point with the bell end upgrade.
- B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
- C. Pipe connecting to manholes or other structures shall terminate flush inside of the structure wall.

- D. Joints for PVC and CISP shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.
- E. Maintain separation of potable water main from sewer piping at crossings a minimum of 10 feet horizontal and 24 inches vertical at crossings (minimum).
- F. Install HDPE piping and fittings to AWWA C901 and C906. Butt fusion welded per ASTM D3261.
- G. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on the drawings.
- H. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 4 feet of cover, except as noted on drawings.
- I. Backfill trench in accordance with Section 31 10 00.

### 3.5 INSTALLATION – CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad with provision for sanitary sewer pipe to be installed to proper elevations.

### 3.6 FIELD QUALITY CONTROL

- A. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner and local jurisdiction.
- B. Provide measuring devices, meters, water, materials, and labor for making the required tests.
- C. Tests shall be conducted in the presence of the Owner's Representative. Test data shall be submitted to the local authority having jurisdiction for review and approval.

**END OF SECTION 33 20 00**

## **SECTION 33 30 00 - SEWER MANHOLES, FRAMES, AND COVERS**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

#### 1.2 Section Includes

1. Modular precast concrete manhole barrels with tongue and groove joints with precast transition to lid.
2. Storm sewer structures.

#### 1.3 Related Sections

1. Section 31 10 00 - Earthwork. Excavation, backfill, and compaction
2. Section 33 40 00 - Storm Drainage

#### 1.4 REFERENCE STANDARDS

##### A. American Society for Testing and Materials (ASTM)

1. ASTM A 48 - Gray Iron Castings
2. ASTM C 55 - Concrete Building Brick
3. ASTM C 478 - Precast Reinforced Concrete Manhole Sections
4. ASTM C 923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
5. ASTM D 1248 - Polyethylene Plastics Molding and Extrusion Materials

##### B. International Masonry Industry All-Weather Council (IMIAC)

1. Recommended Practices and Guide Specification for Cold Weather Masonry Construction

##### C. Kansas State Department of Transportation (KDOT), "Standard Specifications for State Road and Bridge Construction", latest edition, including all revisions.

##### D. Local Governmental Requirements

#### 1.5 SUBMITTALS

##### A. Shop Drawings: Indicate reference to Construction Drawings of manhole locations, elevations, piping with sizes, locations, and elevations of penetrations.

##### B. Product Data: Provide data for manhole covers, manhole steps, component construction, features, configuration, and dimensions.

### **PART 2 - PRODUCTS**

#### 2.1 MANHOLES AND STORM SEWER STRUCTURES

##### A. Precast Concrete: Reinforced precast concrete.

1. Manhole barrel sections conforming to ASTM C 478 with gaskets in accordance with ASTM C 923.
2. Construct manholes of precast concrete sections as required by Construction Drawings to size, shape, and depth indicated.

##### B. Configuration:

1. Barrel Construction: Concentric with eccentric cone top section.
2. Shape: Cylindrical
3. Clear Inside Dimensions: 48-inches diameter minimum or as indicated on Construction Drawings.
4. Design Depth: As indicated on Construction Drawings.

5. Clear Lid Opening: 24-inches minimum
6. Pipe Entry: Provide openings as indicated on Construction Drawings
7. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls. Point up irregularities and rough edges with non-shrinking grout.

- C. Inverts: Shape inverts for smooth flow across structure floor as indicated on Construction Drawings. Use concrete and mortar to obtain proper grade and contour. Finish surface with fine textured wood float.

## 2.2 COMPONENTS

- A. Lid and Frame:
  1. Manufacturer: Neenah Foundry Company, East Jordan Iron Works, or approved equal.
  2. ASTM A 48, Class 30B heavy-duty cast-iron construction, machined flat bearing surface.
  3. Removable lid, closed or open as indicated on Construction Drawings, sealing gasket.
  4. Minimum total weight of 475 pounds unless otherwise shown or specified.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify items specified by other Sections are properly sized and located.
- B. Verify that built-in items are in proper location and ready for roughing into work.
- C. Verify that the excavation for manholes is correct.

### 3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves as indicated on Construction Drawings.

### 3.3 PRECAST MANHOLE CONSTRUCTION

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
  1. After completion of slab foundation, lower first joint of manhole barrel into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert. Pour invert immediately after setting of first section of manhole barrel.
  2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer's recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.
- C. Set cover frames and lids level without tipping, to correct elevations. Utilize pre-cast rings or brick and mortar to achieve final rim elevation. Maximum limit, 4 courses.
- D. Verify top of manhole elevation versus finish grade. Verify flowlines and connection to existing sewers. Verify elevations of existing and proposed utilities that may conflict with proposed sewer line route.

**END OF SECTION 33 30 00**

## **SECTION 33 40 00 - STORM DRAINAGE**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes
1. Storm sewer drainage piping, fittings, and accessories.
  2. Storm drainage structures.

#### 1.2 Related Requirements

1. Section 31 10 00 – Earthwork: Excavation, trenching, backfill, and compaction.
2. Section 31 40 00 – Erosion and Sedimentation Control (Including SWPPP)
3. Section 33 30 00 - Sewer Manholes, Frames, and Covers
4. Section 03 30 00- Cast-In-Place Concrete: (See Architectural / Building Specifications)

#### 1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M36 - Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Under Drains
  2. AASHTO M190 - Bituminous Coated Corrugated Metal Culvert Pipe and Arches
  3. AASHTO M252 - Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter
  4. AASHTO M294 - Corrugated Polyethylene Drainage Tubing, 12 to 48 Inch Diameter
  5. AASHTO MP7-97 - Corrugated Polyethylene Drainage Tubing, 54 to 60 Inch Diameter
- B. American Society for Testing and Materials (ASTM)
1. ASTM A74 - Cast Iron Soil Pipe and Fittings
  2. ASTM A185 - Steel welded Wire Fabric, Plain, for Concrete Reinforcement
  3. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  4. ASTM A746 - Ductile Iron Gravity Sewer Pipe
  5. ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
  6. ASTM C150 - Portland Cement
  7. ASTM C206 - Finished Hydrated Lime
  8. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
  9. ASTM C564 - Rubber Gasket for Cast Iron Soil Pipe and Fittings
  10. ASTM C969 - Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
  11. ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
  12. ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
  13. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- C. American Concrete Institute (ACI)
1. ACI301 - Structural Concrete for Buildings

#### 1.4 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide shop drawings for precast inlets, catch basins and junction boxes.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.
- C. Project Record Documents
1. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
  2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

## 1.5 PROJECT CONDITIONS

- A. Coordinate work with termination of storm sewer connection outside building including connection to municipal storm sewer system.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. Reinforced Concrete Pipe (RCP): ASTM C76, Class III, wall B (Class V under Railroads) except as noted on Drawings, installed with flexible plastic, bitumen gaskets at joints.
  - 1. Gaskets: Joint material for RCP shall be rubber gasket conforming to the requirements of ASTM C443 or "tongue and groove" type filled with cement mortar.
  - 2. Flared end sections shall be Class 1
- B. High Density Polyethylene Pipe (HDPE): AASHTO Designation M252 Type S, M294 Type S and MP7-97 Type S, smooth interior/annular exterior. **Only permitted when specifically indicated on Drawings.** Pipe shall be installed in accordance with pipe manufacturer's installation Guidelines for Culvert Storm Drainage Applications.
  - 1. Pipe Joints and fittings shall conform to AASHTO M252 and M294.
  - 2. Acceptable manufacturers: Advanced Drainage Systems, Inc. "ADS N-12", HANCOR, INC. "Hi-Q", or approved equal.
- C. Polyvinyl Chloride (PVC) Pipe: ASTM D3034, rated SDR 35, continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. **Only permitted when specifically indicated on Drawings.**
  - 1. Pipe joints: ASTM D 3212 using restrained gasket conforming to ASTM F477.
- D. Corrugated Steel (Metal) Pipe (CSP or CMP): ASTM A 760, 16 gauge unless another gauge is indicated on Drawings. Galvanized, aluminized (Type 1R), or bituminous coated as specified on Drawings. **Only permitted when specifically indicated on Drawings.** Corrugated steel pipe may be round pipe, arch pipe, or slotted drainpipe as indicated on Drawings. Slotted drainpipe shall have 1.75-inches wide drain waterway openings and 6 inches minimum height drain guide
  - 1. CSP, bands and appurtenances shall be uniformly coated inside and outside with a 0.05 inch minimum thickness bituminous coating in accordance with AASHTO M190. .
  - 2. CSP shall be supplied with paved inverts or fully lined to provide a smooth interior, smooth flow lining only as indicated on the drawings.
- E. Ductile Iron Pipe (DIP): ASTM A746
  - 1. Fittings: Cast iron conforming to ASTM A74
  - 2. Joint Material: Rubber gasket conforming to the requirements of ASTM C564 for compression joints.
- F. Subdrains: Perforated PVC or flexible corrugated plastic pipe or HDPE as specified herein of the size indicated on the drawings.

### 2.2 DRAINAGE STRUCTURES

- A. Manholes: Conform to Section 33 30 00.
- B. Grates and Frame: Provide in accordance with details shown on Drawings.
  - 1. Provide pedestrian-safe grates are required in high-traffic areas.
  - 2. Acceptable Products:
    - a. Neenah R-1881 Series Narrow-Slotted Grates.
    - b. East Jordan Iron Works V-57xx-80 Series grates.
    - c. Bass & Hays Foundry VFG Pedestrian Rated Series.



- C. Cast-In-Place concrete for drainage structures including manholes, inlets, catch basins, collars, support blocks, headwalls and paved ditches shall conform to ACI 301.
  - 1. Compressive Strength: 3500 psi at 28 days.
  - 2. Reinforcement: ASTM A615, grade 40 or 60 deformed reinforcing bars, and ASTM A185 for wire fabric.
- D. Pre-Cast concrete structures may be used by the Contractor. However, contractor shall be fully responsible for modifications to any precast structure to fit to existing conditions, connections to existing pipes or as needed for the implementation of the designs in the Construction Documents.
- E. Cement Mortar used for paving inverts, filling lift holes, joints, patching and anchoring castings shall consist of one part Portland cement, type I, ASTM C150, 1/4-part hydrated lime, ASTM C206 and 2-1/2 parts clean, well-graded sand and water free of suspended matter, alkali, and containing no industrial or domestic waste.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that trench cut, and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

#### **3.2 PREPARATION**

- A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
- B. Remove large stones or other hard matter that could damage piping or impede consistent backfilling or compaction.
- C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

#### **3.3 INSTALLATION - PIPE**

- A. The pipe shall be inspected for defects and cracks before being lowered into the trench, piece by piece. Any defective, damaged or unsound pipe or any pipe that has had its grade disturbed after laying shall be taken up and replaced. Open ends shall be protected with a stopper to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses and left clean at the completion of the installation.
- B. Excavate pipe trench and place bedding material in accordance with Section 31 10 00.
- C. Installation shall commence at the lowest point for each segment of the route. RCP shall be laid with the groove or bell end upstream. Riveted CSP shall be placed with the inside circumferential laps pointing downstream. Repair damaged bituminous coating on CSP by applying bituminous material conforming to AASHTO M190.
- D. Lay pipe to the required line and slope gradients with the necessary fittings, bends, manhole, risers and other appurtenances placed at the required location as noted on Drawings.
- E. Do not displace or damage pipe when compacting.
- F. No pipe shall be laid in water or when trench conditions are unsuitable for such work.
- G. Joints:

1. Joints shall be constructed as described herein and in accordance with manufacturer's installation instructions with the intent that they be made watertight.
2. For RCP, the joint surface shall be cleaned and washed with water, if necessary, before the joints are made. For tongue and groove joints in smaller sizes, make joints butting the inside of the bell with a cement mortar before joining. The inside joint shall be wiped clean of excess mortar by brush, or a squeegee drawn through the pipe as the laying operations progress. In the larger diameters, which permit the entry of a man, annular space between pipe sections shall be completely filled with mortar and finished off smooth with the inside surface of the pipe.
3. CSP shall be joined by standard corrugated connecting bands. Keep dirt or gravel out from between the pipes and band so that corrugations fit snugly. While being tightened, the bands shall be tapped with a mallet to take up slack and insure a tight joint.
4. PVC fittings shall be attached to the pipe by solvent welding according to the manufacturer's recommendations.

### 3.4 INSTALLATION – MANHOLES, CATCH BASINS, INLETS, AND JUNCTION BOXES

- A. Drainage structures shall be constructed in accordance with details shown on Drawings and in accordance with Section 33 30 00 as applicable.
- B. Precast Sections:
  1. Precast section with bases shall be installed in accordance with Section 31 10 00 and 33 30 00 or as shown on drawings.
  2. Pipe openings shall be aligned to that of the pipe entering and leaving the manhole, etc. Pipe shall be properly aligned with connections to manholes, etc. as shown on the drawings.
- C. Cast-In-Place sections shall be as shown on the drawings and in accordance with Section 33 10 00.
  1. Form bottom of excavation clean and smooth to correct elevation.
  2. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.
  3. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Drawings.
- D. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Invert channels and structure bottoms shall be shaped with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
- E. Frames and Covers:
  1. Frames and covers shall be set to the proper elevation. The frames shall be firmly embedded in mortar approximately 1 inch thick and aligned to fit the top section of the structure.
  2. Bricks set in mortar used to adjust the frame to finished grade shall be limited to no more than four courses.
  3. Adjustment rings used to make adjustments in grade shall be made with the initial ring embedded in mortar and the exterior of the rings parged with mortar not less than 1/2 inch thick. No adjustment made in this manner shall exceed 8 inches.
- F. Concrete cradles shall be constructed as shown on the drawings and as needed when crossing over and under sewer pipe or utility lines. Concrete shall be 3000 psi mix with a minimum thickness of 6 inches.

### 3.5 SUBDRAINS

- A. Subdrains shall be installed in accordance with the details and at the locations shown on the drawings

### 3.6 INSPECTION AND TESTING

- A. General
  - 1. Storm sewer systems and culverts, upon completion or at such time as directed, shall be cleaned, inspected, and tested. The system or culvert shall have a true grade and line. Actual elevations shall be within 0.08 feet of the elevations given on the drawings.
  - 2. After completion of the Work, or any part thereof, the job shall be tested to determine that it has been installed in accordance with the drawings and specifications. In general, the Work shall prove to be in good condition, installed in accordance with the drawings and specifications and ready for use.
  
- B. Cleaning and Testing
  - 1. Visibly inspect and remove all debris and obstructions from storm pipe. Test for infiltration and exfiltration by hydrostatic testing per ASTM C969. Manholes and pipe shall conform to ASTM C969 leakage criteria.
  
- C. Alignment Test
  - 1. After backfilling has been placed and compacted to a depth not less than one foot above top of pipe, a visual inspection shall be made by flashing a light between manholes. Any displacement or misalignment of invert shall be corrected.

**END OF SECTION 33 40 00**

## **SECTION 33 46 00 - SUBDRAINAGE**

### **PART 1 - GENERAL**

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Perforated-wall pipe and fittings.
  - 2. Geotextile filter fabrics.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For geotextile filter fabrics.

### **PART 2 - PRODUCTS**

#### 2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.

#### 2.2 SOIL MATERIALS

- A. Soil materials are specified in Section 31 10 00 "Earthwork."

#### 2.3 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
  - 1. Survivability: AASHTO M 288 Class 2.
  - 2. Styles: Flat and sock.

### **PART 3 - EXECUTION**

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 10 00 "Earthwork."

#### 3.2 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.

- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.
- J. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfills to finish elevations and slope away from building.

### 3.3 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches unless otherwise indicated.
  - 2. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches unless otherwise indicated.
  - 3. Lay perforated pipe with perforations down.

### 3.4 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
  - 2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

**END OF SECTION 33 46 00**

## APPENDIX A1.01 - GEOTECHNICAL DATA

## 1.1 GEOTECHNICAL DATA

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information, but are not a warranty of existing conditions. This Document and its attachments are not part of the Contract Documents.
- B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.
- C. A geotechnical investigation report and Soil-boring data for Project, obtained by Terracon, dated July 20, 2022 is available for viewing, as appended to this Document.

END OF DOCUMENT A1.01



# Geotechnical Engineering Report

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**State of Missouri Highway Patrol Troop A Headquarters**

**Lee's Summit, Missouri**

July 20, 2022

Terracon Project No. 02225131

**Prepared for:**

GastingerWalker&  
Kansas City, Missouri

**Prepared by:**

Terracon Consultants, Inc.  
Lenexa, Kansas

Environmental



Facilities



Geotechnical



Materials



July 20, 2022

GastingerWalker&  
817 Wyandotte Street  
Kansas City, Missouri 64105



Attn: Ms. Jana Bee Triplett  
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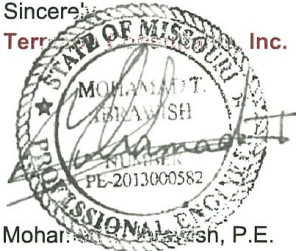
Re: Geotechnical Engineering Report  
State of Missouri Highway Patrol Troop A Headquarters  
NE Independence Avenue, North of NE Colbern Road  
Lee's Summit, Missouri  
Terracon Project No. 02225131

Dear Ms. Bee Triplett:

We have completed a subsurface exploration and geotechnical engineering evaluation for the referenced project. This study was performed in general accordance with Terracon Proposal No. P02225131.rev1, dated June 15, 2022. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,  
Terracon Consultants, Inc.



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**Note:** This report was originally delivered in a web-based format. For more interactive features, please view your project online at [client.terracon.com](http://client.terracon.com).

## ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES  
 SITE LOCATION AND EXPLORATION PLANS  
 EXPLORATION RESULTS  
 SUPPORTING INFORMATION

**Note:** Refer to each individual Attachment for a listing of contents.

**Geotechnical Engineering Report**  
**State of Missouri Highway Patrol Troop A Headquarters**  
**NE Independence Avenue, North of NE Colbern Road**  
**Lee's Summit, Missouri**  
**Terracon Project No. 02225131**  
**July 20, 2022**

## INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering evaluation performed for the proposed new Missouri Highway Patrol Troop A Headquarters to be located at NE Independence Avenue, North of NE Colbern Road in Lee's Summit, Missouri. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides geotechnical recommendations for the following items:

- earthwork
- foundations
- floor slabs
- seismic site class
- pavements

Maps showing the site and boring locations are shown in the **Site Location and Exploration Plan** section. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

## SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
<b>Project Location</b>	The project is located at NE Independence Avenue, North of NE Colbern Road in Lee's Summit, Missouri. Latitude/Longitude: 38.9477° N, 94.3659° W (approximate)
<b>Current Ground Cover</b>	The site is currently surfaced with light vegetation.
<b>Existing Topography</b>	A topographic site plan was not provided. Based on our review of topography using Google Earth, the site slopes downward to the east with elevations ranging from 1020 ft to 1030 feet.

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**PROJECT DESCRIPTION**

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
<b>Project Description</b>	The project includes a 30,000 square foot main building, including vehicle maintenance bays, concrete tilt-up exterior walls, some interior CMU walls, and rooftop mechanical equipment. A 3,300 square foot secondary building (firing range) is also planned at the site.
<b>Finished Floor Elevation (FFE)</b>	The FFE of the structure was not provided. We anticipate the FFE will be within $\pm 2$ feet of existing grades.
<b>Maximum Loads</b>	Anticipated structural loads for the new buildings were not provided. Based on our experience with similar structures, we have considered the following maximum loads: <ul style="list-style-type: none"> <li>■ Columns: 100 kips</li> <li>■ Walls: 5 kips per linear foot</li> <li>■ Slabs: 100 pounds per square foot</li> </ul>
<b>Grading/Slopes</b>	A site grading plan was not provided. We have considered no more than 5 feet of cut/fill will be required to develop final grades.
<b>Below-Grade Structures</b>	No basement level or other below-grade areas are planned.
<b>Free-Standing Retaining Walls</b>	No retaining walls are planned.
<b>Pavements</b>	We understand new pavements will be constructed. No information regarding anticipated vehicle types, axle loads, or traffic volumes was provided. We anticipate the pavements will be utilized primarily by passenger vehicles (cars, pickup trucks, SUV's) with occasional trash collection trucks and delivery trucks.

**GEOTECHNICAL CHARACTERIZATION**

We have developed a general characterization of the subsurface conditions based on the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical evaluation. Conditions encountered at each boring location are indicated on the individual logs. The individual logs are in the **Exploration Results** section and the GeoModel is in the **Figures** section of this report.

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As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Fill	Sandy lean clay
2	Clay	Fat clay, medium stiff to stiff
3	Bedrock	Weathered limestone and shale

The borings were observed during drilling and shortly after completion of drilling for the presence and level of water. Groundwater was observed at a depth of 12 feet in Boring B-7. Groundwater was not encountered in the other borings at these times, but this does not necessarily mean the other borings terminated above the groundwater level. A longer period of time may be required for groundwater to develop and stabilize in a borehole. Longer term observations in piezometers or observation wells, sealed from the influence of surface water, are often required to define groundwater levels.

Groundwater levels may fluctuate due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. "Perched" water could occur above lower permeability soil layers and/or near the soil/bedrock interface, and "trapped" water could be present within existing fill materials. Therefore, groundwater conditions at other times may be different than the conditions encountered in our exploratory borings. The potential for water level fluctuations and perched water should be considered when developing design and construction plans and specifications for the project.

## GEOTECHNICAL OVERVIEW

Based on conditions encountered at the boring locations, it appears feasible to support the new buildings on shallow spread footings bearing on medium stiff to stiff native clay and/or engineered fill materials.

Existing fill materials composed of sandy lean clay were encountered to a depth of about 3 feet at Boring B-9, which is located within the planned pavement area. Although fill was not encountered in the borings performed within proposed building areas, fill could be present between boring locations and in other areas of the site where borings were not performed. New structures supported on/above existing undocumented fill materials may not perform predictably and could experience larger-than-tolerable movements (settlement and/or heave) resulting in cracking, uneven floors, sticking doors, and other damage. To prevent these conditions, any existing fill encountered within the planned new building footprint (if encountered) should be completely removed and replaced with properly compacted engineered fill. If existing clay fill

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materials are encountered in pavement areas, the existing fill may be left in place below pavements provided it is observed and tested by Terracon during construction.

Expansive fat clay soils were encountered at the site. These materials have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. We recommend the floor slabs be supported on at least 24 inches of low volume change (LVC) material. In areas that are currently above or less than 2 feet below the planned bottom of floor slab level, native fat clay soils should be undercut to accommodate placement of LVC material. In areas where more than 2 feet of fill will be placed below the bottom-of-floor-slab level, at least the upper 24 inches of new engineered fill should consist of LVC material. Placement of a layer of LVC material below floor slabs, as recommended in this report, will not eliminate all future subgrade volume change and resultant floor slab movements. However, use of an LVC zone should reduce the potential for subgrade volume change. Details regarding the LVC zone are provided in **Earthwork**.

Depending on how the site is graded, excavation of bedrock could be required to place utilities. In our experience, conventional heavy duty excavation equipment such as large track-mounted hoes equipped with rock teeth or bulldozers equipped with ripping attachments are often used to excavate bedrock materials that were penetrated with flight augers in the exploratory borings (e.g., highly weathered limestone). Excavation of rock formations that cannot be penetrated with flight augers is usually much more difficult and often requires the use of pneumatic breakers or other rock excavation techniques. Excavation of bedrock in confined excavations such as footings and utility trenches will be difficult.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure could still occur. The severity of cracking and other cosmetic damage caused by movement of the floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request. The **General Comments** section provides an understanding of the report limitations.

## **EARTHWORK**

Site preparation, excavation, subgrade preparation and placement of engineered fills should conform to recommendations presented in this section. The recommendations presented for design and construction of earth-supported elements including foundations, slabs, and pavements are contingent upon the recommendations outlined in this section being followed. We recommend earthwork on this project be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of subgrade preparation, engineered fill,

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foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

**Site Preparation**

Vegetation, topsoil, and any loose, soft, or otherwise unsuitable soils present within the proposed construction areas should be stripped. Based on information obtained at the boring locations, stripping depths on the order of 3 inches should be anticipated to remove the root zone materials. However, greater stripping depths may be required in areas not explored by the borings. Organic soils removed during site preparation should not be used as fill beneath the proposed new building and pavement areas.

If existing fill is present within the proposed building footprints, the fill should be removed to expose the underlying native soils. Existing fill may be left in place below pavements provided it is thoroughly observed and tested by a Terracon representative during construction, and any soft areas and unsuitable materials are removed and replaced with engineered fill.

The soils within the planned building areas should be further undercut as necessary to accommodate placement of the recommended 24-inch thick LVC layer below floor slabs. The undercut areas should extend a minimum of 5 feet laterally outside the building wall lines. Undercutting to facilitate placement of the LVC layer would not be necessary in areas where more than 2 feet of fill will be placed to develop the floor slab subgrade level.

Following initial stripping and any necessary undercutting, the exposed soils should be proofrolled. A Terracon representative should observe the proofrolling. Proofrolling can be accomplished using a loaded tandem-axle dump truck with a gross weight of at least 20 tons, or similarly loaded equipment. Areas that display excessive deflection (pumping) or rutting during proofroll operations should be improved by scarification/compaction or by removal and replacement with engineered fill.

**Fill Material Types**

A sample of each fill material type should be tested prior to being used on the site. Our professional opinions concerning suitability of fill materials are presented in the following table.

Fill Type <sup>1</sup>	USCS Classification	Acceptable Location for Placement
Low Volume Change (LVC) material	GM <sup>2</sup> or CL (LL<45 and PI<23)	All locations and elevations, except where free-draining material is required

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Fill Type <sup>1</sup>	USCS Classification	Acceptable Location for Placement
On-site soils	CH (native clay soils and existing fill soils)	Pavement areas and at depths greater than 24 inches below building finished grade  Existing fill should be observed, tested and approved by Terracon. Organics, rock/rubble fragments larger than 3 inches, debris, or other unsuitable materials should be removed prior to re-use of the existing fill in engineered fill sections.
Well-graded granular	GW <sup>3</sup>	Where free-draining material is required

1. Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. MoDOT Type 5 or an approved alternate gradation of crushed limestone aggregate
3. Granular materials with less than 5 percent fines (material passing the #200 sieve), such as ASTM C33 Size No. 57 aggregate or an approved alternate gradation.

Low volume change (LVC) material placed below the building floor slabs can consist of well-graded crushed stone aggregate (e.g., MoDOT Type 5). Lean clay soils with a liquid limit less than 45 and plasticity index less than 23 could also be used as LVC material, but these soils would be susceptible to softening and disturbance if they become wetted by surface water and precipitation. Soils that meet the LVC criteria were not encountered in the borings. Therefore, the use of imported LVC materials should be expected. As an alternative to importing LVC materials, the on-site clay soils could be modified by incorporating portland cement, lime or lime kiln dust to create LVC material. Terracon can provide additional recommendations regarding chemical modification of the on-site soils upon request. If a granular leveling course (such as crushed stone aggregate) is used immediately below the floor slabs, this material can be considered part of the LVC zone.

**Fill Compaction Requirements**

Item	Description
Lift Thickness (maximum)	9 inches in loose thickness when large, self-propelled compaction equipment is used 4 inches when small, hand-guided equipment (plate or "jumping jack" compactor) is used
Minimum Compaction Requirements <sup>1</sup>	At least 95 percent of the material's maximum dry density <sup>1</sup>
Moisture Content of Clay Soil	LL<45 -2 to +2 percent of optimum moisture content value <sup>1</sup>
	LL>45 0 to 4 percent above the optimum moisture content value <sup>1</sup>



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Item	Description
Moisture Content of Granular Material	Sufficient to achieve compaction without pumping when proofrolled
1. As determined by the standard Proctor test (ASTM D 698)	

We recommend that engineered fill be tested for moisture content and compaction during placement. If the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

**Utility Trench Backfill**

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of clay fill to reduce the infiltration and conveyance of surface water through the trench backfill.

Utility trenches are common sources of water infiltration and migration. All utility trenches that penetrate beneath buildings should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building. We recommend constructing an effective "trench plug" that extends at least 5 feet out from the face of the building exterior. The plug material should consist of clay compacted as recommended in **Earthwork**. The clay fill should be placed to completely surround the utility line and be compacted in accordance with recommendations in this report. Alternatively, flowable fill could be used to construct the trench plug.

**Grading and Drainage**

During construction, grades should be developed to direct surface water flow away from or around the site. Exposed subgrades should be sloped to provide positive drainage so that saturation of subgrades is avoided. Surface water should not be permitted to accumulate on the site. Final surrounding grades should promote rapid surface drainage away from the structures. Accumulation of water adjacent to the structure could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement or expansion/heave.

After construction of the structures and pavements have been completed, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the structures should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

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**Earthwork Construction Considerations**

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of engineered fill, backfilling of excavations into completed subgrades, and just prior to construction of foundations, slabs, and pavements.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted prior to floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Rock excavation methods may be required for deeper excavations, such as utility trenches, depending upon the depth of excavation and the type of rock encountered. In our experience, highly weathered shale bedrock strata that can be easily penetrated with a flight auger can typically be excavated using track-hoes with rock teeth or ripper equipped dozers. Excavation of harder bedrock (such as limestone or less weathered shale) will likely require the use of jackhammers or pneumatic breakers. Excavation of rock in confined areas (such as trenches) is usually difficult, even above the level of auger refusal.

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## SHALLOW FOUNDATIONS

### Foundation Design Parameters

Based on the conditions encountered at the borings, the building can be supported on shallow footing foundations that bear on medium stiff to stiff, native clay soils and/or engineered fill.

Description	Value
<b>Maximum net allowable bearing pressure</b> <sup>1</sup>	2,500 psf
<b>Minimum embedment below finished grade for frost protection</b> <sup>2</sup>	3 feet
<b>Minimum footing widths</b>	Isolated footings: 30 inches Continuous footings: 16 inches
<b>Estimated total settlement</b> <sup>3</sup>	1 inch or less
<b>Estimated differential settlement</b> <sup>3</sup>	1/2 to 2/3 of the total settlement over a horizontal distance of 50 feet

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any soft soils or other unsuitable materials, if encountered, will be undercut and replaced with engineered fill.
2. This embedment depth is recommended for perimeter footings and footings beneath unheated areas to provide frost protection and to reduce the effects of seasonal moisture variations in the foundation bearing soils. Interior footings in heated areas may be supported at shallower depths, provided they are not exposed to freezing conditions during construction.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of engineered fill below the footings, and the quality of the earthwork operations and footing construction.

### Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose materials prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. If the soils at the bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. If the excavations must remain open overnight or for an extended period of time, placement of a lean concrete mud-mat over the bearing soils should be considered.

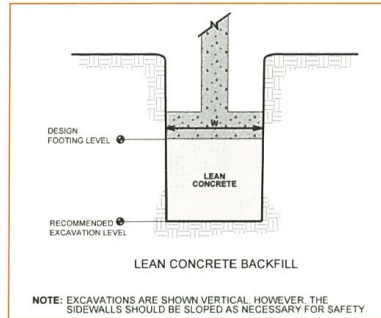
All footing bearing surfaces should be observed and tested by Terracon. If unsuitable conditions are encountered, footing excavations should be extended deeper to suitable bearing materials.

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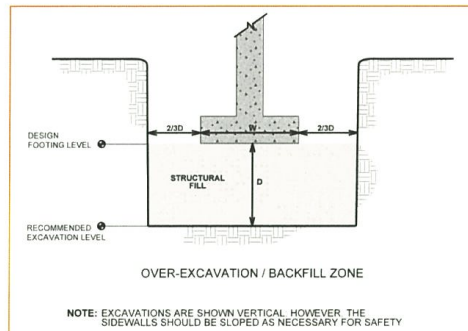
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Footings can bear directly on suitable soils at the lower level or on lean concrete backfill as shown in the following figure.



The footings could also bear on properly compacted backfill extending down to suitable soils as shown in the following figure. Overexcavation for compacted engineered fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material (e.g., MoDOT Type 5 aggregate or an approved alternate gradation) placed and compacted as recommended in **Earthwork**.



**SEISMIC CONSIDERATIONS**

Code	Site Class
2012 International Building Code (IBC)	C <sup>1</sup>
1. The 2012 International Building Code (IBC) seismic site class definitions are based on average properties of the subsurface profile to a depth of 100 feet. The exploratory borings terminated at a maximum depth	

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of 15 feet, with most of the borings encountering limestone or shale bedrock. Our opinion of site class is based on boring data and our knowledge of local geological and geotechnical conditions.

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## FLOOR SLABS

### Floor Slab Design Parameters

Item	Description
<b>Floor Slab Support</b>	At least 24 inches of low volume change (LVC) material over native clay soils and/or engineered fill
<b>Modulus of Subgrade Reaction</b>	100 pounds per square inch per inch of deflection (psi/in or pci) for point loading conditions
<b>Granular Leveling Course Layer Thickness</b> <sup>1,2</sup>	4 inches (minimum)

1. Well graded crushed stone (e.g., MoDOT Type 5 aggregate) or open-graded crushed stone (e.g., ASTM C33, Size No. 57 aggregate) can be used as the leveling course.

2. These granular materials may be considered part of the LVC zone.

Joints should be constructed in slabs at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of cracks. Joints or any cracks that develop in the floor slab should be sealed with a waterproof, non-extruding compressible compound.

Loads on footings that support structural walls and column loads are typically greater than floor slab loads. Consequently, footings should be expected to settle more than the adjacent floor slabs. The structural engineer should consider the potential for differential movement between foundations and grade-supported floor slabs.

Typically, some increase in the floor slab subgrade moisture content will occur because of gradual accumulation of capillary moisture, which would otherwise evaporate if the floor slab had not been constructed. The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

### Floor Slab Construction Considerations

The subgrade should be maintained within the moisture content range recommended for engineered fill until the floor slab is constructed. If the subgrade becomes desiccated prior to construction of the floor slab, the affected material should be removed or the materials should be scarified, moistened, and compacted. Upon completion of grading operations in the building area, care should be taken to maintain the subgrade within the moisture content and density ranges recommended for engineered fill prior to construction of the building floor slab.

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On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall etc. As a result, the floor slab subgrade soils may not be suitable for placement of the granular course and/or concrete at the time of building construction, and corrective action may be required.

Terracon should evaluate the condition of the floor slab subgrades immediately prior to placement of the granular leveling course and construction of the slabs. Particular attention should be paid to areas containing backfilled trenches and high traffic areas that were previously disturbed during construction. Where unsuitable conditions are located within the floor slab subgrade soils, the subgrade should be improved by removing and replacing the affected material with properly compacted fill.

## PAVEMENTS

### Pavement Subgrade Preparation

Pavement subgrades are expected to consist of on-site native clay soils. The pavement subgrades should be proofrolled as recommended in **Earthwork**. If soft or otherwise unsuitable areas are observed, additional over-excavation and replacement will be needed.

Grading and paving are commonly performed by separate contractors and there is often a time lapse between the end of grading operations and the commencement of paving. Subgrades prepared early in the construction process may become disturbed by construction traffic. Non-uniform subgrades often result in poor pavement performance and local failures relatively soon after pavements are constructed. Depending on the paving equipment used by the contractor, measures may be required to improve subgrade strength to greater depths for support of heavily loaded concrete/asphalt trucks.

We recommend the moisture content and density of the subgrade be evaluated and the pavement subgrades be proofrolled (using a loaded tandem-axle dump truck with a minimum gross weight of 20 tons or similarly loaded rubber-tire equipment) within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be scarified, moisture conditioned, and compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. The subgrade should be in its finished form at the time of the final review.

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**Opinions of Minimum Pavement Thickness**

Pavement thickness depends upon many factors including but not limited to:

- applied wheel/axle loads and number of repetitions
- subgrade and pavement material characteristics
- climate conditions
- site and pavement drainage

Specific information regarding anticipated vehicle types, axle loads, and traffic volumes was not provided at the time of this report. The "Parking Lots" pavement section considers 4-tire, 2-axle personal vehicle traffic only (cars, vans, pickups and SUVs). The "Drives" pavement section considers personal vehicle traffic and a maximum of ten delivery trucks/trash collection trucks per week. Our recommendations for full depth asphaltic cement concrete (ACC) pavement, ACC pavement over aggregate base, and Portland cement concrete (PCC) pavement sections are outlined in the following table.

Pavement Type	Parking Lots	Drives
<b>Full depth ACC</b>	2 inches ACC surface 4 inches ACC base	2 inches ACC surface 6 inches ACC base
<b>ACC over aggregate base</b>	2 inches ACC surface 2 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)	2 inches ACC surface 4 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)
<b>PCC</b>	5 inches PCC 4 inches open graded rock (ASTM C33 Size No. 57 aggregate or similar)	6 inches PCC 4 inches open graded rock (ASTM C33 Size No. 57 aggregate or similar)

1. For trash container pads, we recommend a PCC pavement section be used consisting of 7 inches (minimum) of PCC over 4 inches (minimum) of open graded rock (ASTM C33 Size No. 57 aggregate or similar) on a compacted soil subgrade. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

PCC pavements will perform better than ACC in areas where short-radii turning and braking are expected (i.e., entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to heavy static loads.

Construction traffic on the pavements was not considered in developing our opinions of minimum pavement thickness. If the pavements will be subject to construction equipment/vehicles, the pavement sections should be revised to consider the additional loading.

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Pavements and subgrades will be subject to freeze-thaw cycles and seasonal fluctuations in moisture content. Pavement thickness design methods are intended to provide adequate thickness of structural materials over a particular subgrade such that wheel loads are reduced to a level that the subgrade can support. The subgrade support parameters for pavement thickness design do not account for shrink/swell movements of a subgrade constructed of expansive clay soils. Therefore, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

The pavement sections provided above consider that the subgrade soils will not experience significant increases in moisture content. Paved areas should be sloped to provide rapid drainage of surface water and to drain water away from the pavement edges. Pavements should be designed so water does not accumulate on or adjacent to the pavement, since this could saturate and soften the subgrade soils and subsequently accelerate pavement deterioration.

Periodic maintenance of the pavements will be required. Cracks should be sealed, and areas exhibiting distress should be repaired promptly to help prevent further deterioration. Even with periodic maintenance, some movement and related cracking may still occur and repairs may be required.

## GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between boring locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Support of floor slabs and pavements above existing fill is discussed in this report. Even with the construction observation/testing recommended in this report, a risk remains for the owner that unsuitable materials within or buried by the fill will not be discovered. This may result in larger than normal settlement and damage to slabs and pavements supported above existing fill, requiring additional maintenance. This risk cannot be eliminated without removing the existing fill from below the building and pavement areas, but can be reduced by thorough observation and testing as discussed herein.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of



**Geotechnical Engineering Report**

State of Missouri Highway Patrol Troop A Headquarters ■ Lee's Summit, Missouri  
July 20, 2022 ■ Terracon Project No. 02225131



pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

## FIGURES

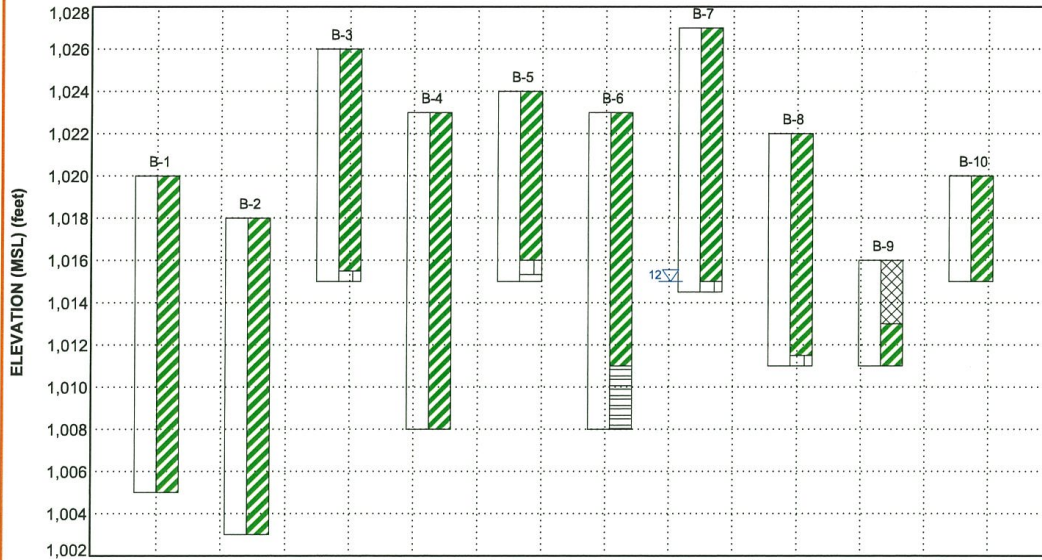
### Contents:

GeoModel

Responsive ■ Resourceful ■ Reliable

**GEOMODEL**

State of Missouri Highway Patrol Troop A Headquarters ■ Lee's Summit, MO  
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This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Fill	Sandy lean clay
2	Clay	Fat Clay, medium stiff to stiff
3	Bedrock	Weathered limestone and shale

**LEGEND**

- Fat Clay
- Limestone
- Shale
- Fill

First Water Observation

**NOTES:**

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

## ATTACHMENTS

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**Geotechnical Engineering Report**

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## EXPLORATION AND TESTING PROCEDURES

### Field Exploration

The borings were located in the field by Terracon personnel using a hand-held GPS unit with a horizontal precision of  $\pm 20$  feet. Ground surface elevations indicated on the boring logs were estimated using an online mapping application.

The borings were drilled with a ATV-mounted, rotary drill rig using solid-stem, continuous flight augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using thin-walled tube and split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outside diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. The drill crew backfilled the borings with auger cuttings after completion of drilling/sampling and prior to leaving the site.

The drill crew prepared a field log of each boring to record data including visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The final boring logs included with this report represent the engineer's interpretation of the subsurface conditions at the borings based on field and laboratory data and observation of the samples.

### Laboratory Testing

Representative soil samples were tested in the laboratory to measure their natural water content, dry unit weight, and Atterberg limits. The test results are provided on the boring logs included in **Exploration Results**.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report.

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EXPLORATION AND TESTING PROCEDURES 1 of 2

**Geotechnical Engineering Report**

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The bedrock materials encountered in the borings were described in accordance with the appended Description of Rock Properties on the basis of drilling characteristics and visual classification of disturbed auger cuttings. Rock core samples and petrographic analysis may indicate other rock types.

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EXPLORATION AND TESTING PROCEDURES 2 of 2

## SITE LOCATION AND EXPLORATION PLANS

### Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

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**SITE LOCATION**

State of Missouri Highway Patrol Troop A Headquarters ■ Lee's Summit, Missouri  
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**EXPLORATION PLAN**

State of Missouri Highway Patrol Troop A Headquarters ■ Lee's Summit, Missouri  
July 20, 2022 ■ Terracon Project No. 02225131

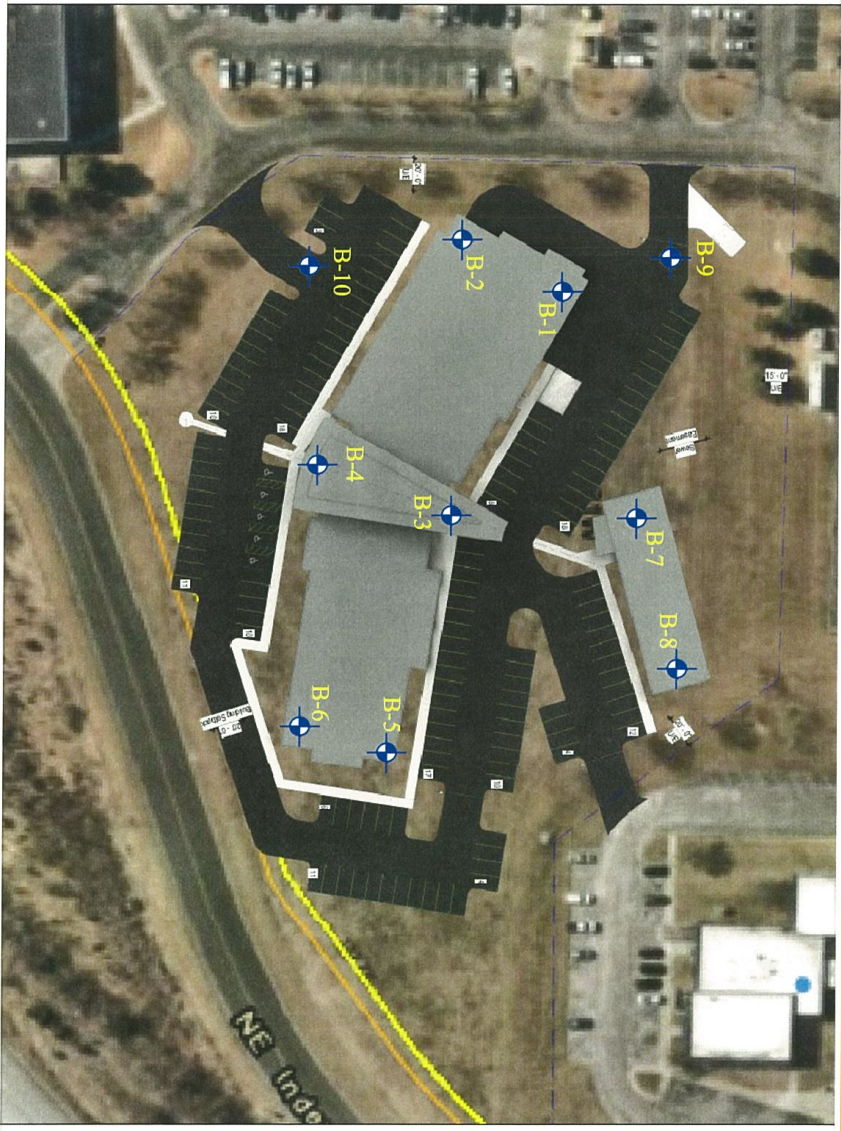


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES


MAP PROVIDED BY MICROSOFT BING MAPS

## EXPLORATION RESULTS

### Contents:

Boring Logs (B-1 through B-10)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		See <a href="#">Exploration Plan</a> Latitude: 38.9480° Longitude: -94.3666° Surface Elev.: 1020 (Ft.) ELEVATION (Ft.)								LL-PL-PI	
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff									
			5			6-5-6 N=11	6040	19.5	98	61-24-37	
			10			3-3-4 N=7		27.8			
			10			4-4-3 N=7		30.5			
		- shaley below 12 feet									
			15			3-5-7 N=12		28.2			
		<b>Boring Terminated at 15 Feet</b>	15.0								
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger					See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (if any).			Notes:			
Abandonment Method: Boring backfilled with auger cuttings upon completion.					See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.						
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered					 15620 W 113th St Lenexa, KS		Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
							Drill Rig: CME 55		Driller: C.J.		
							Project No.: 02225131				

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL: 02225131 STATE OF MISSOURI.GPJ TERRACON\_DATATEMPLATE.GDT 7/19/22

## BORING LOG NO. B-2

<b>PROJECT:</b> State of Missouri Highway Patrol Troop A Headquarters <b>SITE:</b> NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO	<b>CLIENT:</b> Gastinger Walker & Kansas City, MO
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MODEL LAYER	GRAPHIC LOG	LOCATION See <a href="#">Exploration Plan</a> Latitude: 38.9478° Longitude: -94.3667°  Surface Elev.: 1018 (Ft.) ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS  LL-PL-PI
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff								
			5			3-4-5 N=9		24.8		
			5				4720	26.2	97	
			10			2-3-3 N=6		28.7		
			10			2-3-3 N=6		29.2		
		- shaley below 12 feet								
			15			3-4-4 N=8		23.4		
		<b>Boring Terminated at 15 Feet</b>								

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Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic


Advancement Method: Continuous Flight Auger	See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (If any).  See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.	Notes:
Abandonment Method: Boring backfilled with auger cuttings upon completion.		
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered	15620 W 113th St Lenexa, KS	Boring Started: 07-08-2022 Drill Rig: CME 55 Project No.: 02225131
		Boring Completed: 07-08-2022 Driller: C.J.

BORING LOG NO. B-3										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION	DEPTH (FT.)	ELEVATION (FT.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS
		See Exploration Plan Latitude: 38.9478° Longitude: -94.3661° Surface Elev.: 1026 (Ft.)									LL-PL-PI
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff									
			5	1015.5			3-3-4 N=7	8550	21.8	98	
							3-3-4 N=7		25.8		
							2-2-3 N=5		30.5		
			10.5	1015.5							
		<b>LIMESTONE</b>	11.0	1015							
		<i>Auger Refusal at 11 Feet</i>									
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger				See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).				Notes:			
Abandonment Method: Boring backfilled with auger cuttings upon completion.				See Supporting Information for explanation of symbols and abbreviations.							
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered				 15620 W 113th St Lenexa, KS				Boring Started: 07-08-2022		Boring Completed: 07-08-2022	
								Drill Rig: CME 55		Driller: C.J.	
								Project No.: 02225131			

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 02225131 STATE OF MISSOURI.GPJ TERRACON\_DATATEMPLATE.GDT 7/19/22

BORING LOG NO. B-4										Page 1 of 1		
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO							
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO												
MODEL LAYER	GRAPHIC LOG	LOCATION	DEPTH (Ft.)	ELEVATION (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		See Exploration Plan Latitude: 38.9476° Longitude: -94.3662° Surface Elev.: 1023 (Ft.)									LL-PL-PI	
		<b>FAT CLAY (CH)</b> , brown, medium stiff to stiff										
			5				3-4-4 N=8		18.4			
								3330	25.6	96		
							3-2-3 N=5		26.8			
			10				3-4-5 N=9		42.1			
		- shaley below 12 feet										
			15	1008			7-7-7 N=14		20.8			
		<b>Boring Terminated at 15 Feet</b>										
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic		
Advancement Method: Continuous Flight Auger				See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (if any).				Notes:				
Abandonment Method: Boring backfilled with auger cuttings upon completion.				See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.								
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered				 15620 W 113th St Lenexa, KS				Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
								Drill Rig: CME 55		Driller: C.J.		
								Project No.: 02225131				

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BORING LOG NO. B-5										Page 1 of 1		
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO							
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO												
MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.9477° Longitude: -94.3655°	DEPTH (FL.)	ELEVATION (FL.)	DEPTH (FL.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff		Surface Elev.: 1024 (Ft.)								
			8.0	1016	5			2-3-3 N=6	5950	23.9	99	
			9.0	1015				2-3-5 N=8		27.8		
		<b>LIMESTONE</b> , slightly weathered						50/0"				
		<b>Auger Refusal at 9 Feet</b>										
Stratification lines are approximate. In-situ, the transition may be gradual.					Hammer Type: Automatic							
Advancement Method: Continuous Flight Auger				See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).				Notes:				
Abandonment Method: Boring backfilled with auger cuttings upon completion.				See Supporting Information for explanation of symbols and abbreviations.								
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered				 15620 W 113th St Lenexa, KS				Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
								Drill Rig: CME 55		Driller: C.J.		
								Project No.: 02225131				

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BORING LOG NO. B-6										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.9476° Longitude: -94.3656°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		Surface Elev.: 1023 (Ft.) ELEVATION (Ft.)								LL-PL-PI	
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff									
			5			2-3-3 N=6	4500	1.3	96	74-26-48	
						2-2-3 N=5		27.6			
			10			11-5-3 N=8		24.3			
			12.0								
		<b>SHALE</b> , light brown and gray	1011								
			15.0			6-8-14 N=22		19.5			
		<b>Boring Terminated at 15 Feet</b>	15								
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger				See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).			Notes:				
Abandonment Method: Boring backfilled with auger cuttings upon completion.				See Supporting Information for explanation of symbols and abbreviations.							
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered				 15620 W 113th St Lenexa, KS			Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
							Drill Rig: CME 55		Driller: C.J.		
							Project No.: 02225131				

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BORING LOG NO. B-7										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.9481° Longitude: -94.3661°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		Surface Elev.: 1027 (Ft.)								LL-PL-PI	
		DEPTH ELEVATION (Ft.)									
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff									
			5			3-4-5 N=9	6480	19.3	102		
						3-3-5 N=8		26.8			
			10			4-4-5 N=9		28.3			
			12.0								
		12.5 <b>LIMESTONE</b>	1015								
		<b>Auger Refusal at 12.5 Feet</b>	1014.5								
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger				See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (if any).			Notes:				
Abandonment Method: Boring backfilled with auger cuttings upon completion.				See Supporting Information for explanation of symbols and abbreviations.							
<b>WATER LEVEL OBSERVATIONS</b>				 15620 W 113th St Lenexa, KS			Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
▽ While drilling							Drill Rig: CME 55		Driller: C.J.		
							Project No.: 02225131				

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BORING LOG NO. B-8										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		See Exploration Plan Latitude: 38.9482° Longitude: -94.3657° Surface Elev.: 1022 (Ft.)	ELEVATION (Ft.)							LL-PL-PI	
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff to stiff									
			5			4-5-5 N=10	9840	16.6	100	59-23-36	
			10			4-4-5 N=9		24.2			
			10.5			2-2-2 N=4		37.9			
		<b>LIMESTONE</b>	1011.5								
		<b>Auger Refusal at 11.5 Feet</b>	1011								
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger					See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).					Notes:	
Abandonment Method: Boring backfilled with auger cuttings upon completion.					See Supporting Information for explanation of symbols and abbreviations.						
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered					 15620 W 113th St Lenexa, KS		Boring Started: 07-08-2022		Boring Completed: 07-08-2022		
							Drill Rig: CME 55		Driller: C.J.		
							Project No.: 02225131				

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<b>BORING LOG NO. B-9</b>										Page 1 of 1	
<b>PROJECT: State of Missouri Highway Patrol Troop A Headquarters</b>					<b>CLIENT: Gastinger Walker &amp; Kansas City, MO</b>						
<b>SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO</b>											
MODEL LAYER	GRAPHIC LOG	LOCATION See <a href="#">Exploration Plan</a> Latitude: 38.9482° Longitude: -94.3666° Surface Elev.: 1016 (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		DEPTH ELEVATION (Ft.)								LL-PL-PI	
	3.0	<b>FILL - SANDY LEAN CLAY (CL)</b> , with gravel, brown and gray, stiff	1013		X	4-4-5 N=9	15.1				
	5.0	<b>FAT CLAY (CH)</b> , brown, medium stiff	1011		X	3-3-5 N=8	19.0				
<b>Boring Terminated at 5 Feet</b>											
Stratification lines are approximate. In-situ, the transition may be gradual. Hammer Type: Automatic											
Advancement Method: Continuous Flight Auger  Abandonment Method: Boring backfilled with auger cuttings upon completion.				See <a href="#">Exploration and Testing Procedures</a> for a description of field and laboratory procedures used and additional data (if any).  See <a href="#">Supporting Information</a> for explanation of symbols and abbreviations.			Notes:				
<b>WATER LEVEL OBSERVATIONS</b> Groundwater not encountered				 15620 W 113th St Lenexa, KS		Boring Started: 07-08-2022 Drill Rig: CME 55 Project No.: 02225131		Boring Completed: 07-08-2022 Driller: C.J.			

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BORING LOG NO. B-10										Page 1 of 1	
PROJECT: State of Missouri Highway Patrol Troop A Headquarters					CLIENT: Gastinger Walker & Kansas City, MO						
SITE: NE Independence Ave, N of NE Colbern Rd Lee's Summit, MO											
MODEL LAYER	GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 38.9476° Longitude: -94.3666°	DEPTH (FL.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
		Surface Elev.: 1020 (Ft.) ELEVATION (FL.)								LL-PL-PI	
		<b>FAT CLAY (CH)</b> , brown and gray, medium stiff				4-3-5 N=8		23.8			
			5.0			3-3-4 N=7		26.9			
		<b>Boring Terminated at 5 Feet</b>	1015								
Stratification lines are approximate. In-situ, the transition may be gradual.										Hammer Type: Automatic	
Advancement Method: Continuous Flight Auger			See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).			Notes:					
Abandonment Method: Boring backfilled with auger cuttings upon completion.			See Supporting Information for explanation of symbols and abbreviations.								
<b>WATER LEVEL OBSERVATIONS</b>			 15620 W 113th St Lenexa, KS			Boring Started: 07-08-2022		Boring Completed: 07-08-2022			
Groundwater not encountered						Drill Rig: CME 55		Driller: C.J.			
						Project No.: 02225131					

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL\_02225131 STATE OF MISSOURI.GPJ TERRACON\_DATATEMPLATE.GDT 7/19/22

## **SUPPORTING INFORMATION**

### **Contents:**







General Notes  
Unified Soil Classification System  
Description of Rock Properties

Note: All attachments are one page unless noted above.

**GENERAL NOTES****DESCRIPTION OF SYMBOLS AND ABBREVIATIONS**

State of Missouri Highway Patrol Troop A Headquarters ■ Lee's Summit, MO  
Terracon Project No. 02225131



SAMPLING	WATER LEVEL	FIELD TESTS
 Shelby Tube  Split Spoon	 Water Initially Encountered	N Standard Penetration Test Resistance (Blows/Ft.)
	 Water Level After a Specified Period of Time	(HP) Hand Penetrometer
	 Water Level After a Specified Period of Time	(T) Torvane
	 Cave In Encountered	(DCP) Dynamic Cone Penetrometer
	<p>Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.</p>	UC Unconfined Compressive Strength  (PID) Photo-Ionization Detector  (OVA) Organic Vapor Analyzer

**DESCRIPTIVE SOIL CLASSIFICATION**

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

**LOCATION AND ELEVATION NOTES**

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See [Exploration and Testing Procedures](#) in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

**STRENGTH TERMS**

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Standard Penetration or N-Value Blows/Ft.
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

**RELEVANCE OF SOIL BORING LOG**

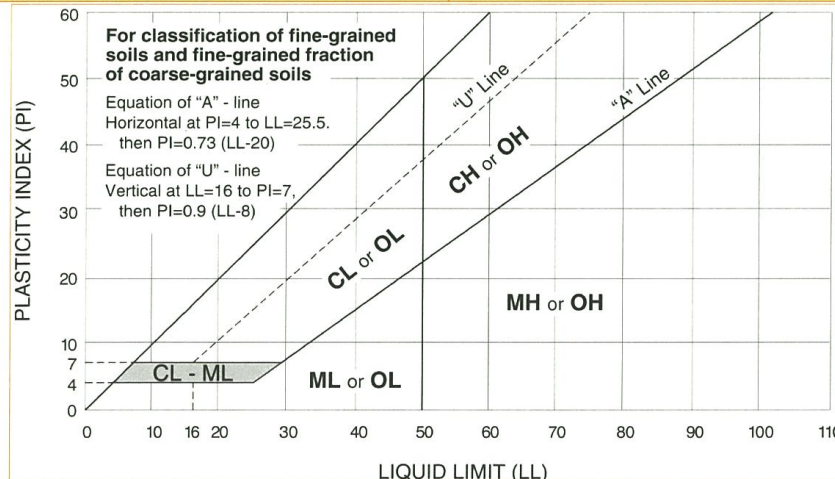
The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM



Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification		
				Group Symbol	Group Name <sup>B</sup>	
<b>Coarse-Grained Soils:</b> More than 50% retained on No. 200 sieve	<b>Gravels:</b> More than 50% of coarse fraction retained on No. 4 sieve	<b>Clean Gravels:</b> Less than 5% fines <sup>C</sup>	$Cu \geq 4$ and $1 \leq Cc \leq 3$ <sup>E</sup>	GW	Well-graded gravel <sup>F</sup>	
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ <sup>E</sup>	GP	Poorly graded gravel <sup>F</sup>	
		<b>Gravels with Fines:</b> More than 12% fines <sup>C</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>F, G, H</sup>	
			Fines classify as CL or CH	GC	Clayey gravel <sup>F, G, H</sup>	
	<b>Sands:</b> 50% or more of coarse fraction passes No. 4 sieve	<b>Clean Sands:</b> Less than 5% fines <sup>D</sup>	$Cu \geq 6$ and $1 \leq Cc \leq 3$ <sup>E</sup>	SW	Well-graded sand <sup>I</sup>	
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ <sup>E</sup>	SP	Poorly graded sand <sup>I</sup>	
		<b>Sands with Fines:</b> More than 12% fines <sup>D</sup>	Fines classify as ML or MH	SM	Silty sand <sup>G, H, I</sup>	
			Fines classify as CL or CH	SC	Clayey sand <sup>G, H, I</sup>	
<b>Fine-Grained Soils:</b> 50% or more passes the No. 200 sieve	<b>Silts and Clays:</b> Liquid limit less than 50	<b>Inorganic:</b>	$PI > 7$ and plots on or above "A"	CL	Lean clay <sup>K, L, M</sup>	
			$PI < 4$ or plots below "A" line <sup>J</sup>	ML	Silt <sup>K, L, M</sup>	
		<b>Organic:</b>	Liquid limit - oven dried Liquid limit - not dried	$< 0.75$	OL	Organic clay <sup>K, L, M, N</sup> Organic silt <sup>K, L, M, O</sup>
		<b>Inorganic:</b>	$PI$ plots on or above "A" line	CH	Fat clay <sup>K, L, M</sup>	
	<b>Silts and Clays:</b> Liquid limit 50 or more		$PI$ plots below "A" line	MH	Elastic Silt <sup>K, L, M</sup>	
		<b>Organic:</b>	Liquid limit - oven dried Liquid limit - not dried	$< 0.75$	OH	Organic clay <sup>K, L, M, P</sup> Organic silt <sup>K, L, M, Q</sup>
			$PI$ plots on or above "A" line			
			$PI$ plots below "A" line			
<b>Highly organic soils:</b>	Primarily organic matter, dark in color, and organic odor			PT	Peat	

- <sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve.
- <sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- <sup>C</sup> Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- <sup>D</sup> Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
- <sup>E</sup>  $Cu = D_{60}/D_{10}$      $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
- <sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.
- <sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
- <sup>H</sup> If fines are organic, add "with organic fines" to group name.
- <sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.
- <sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- <sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- <sup>L</sup> If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.
- <sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.
- <sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.
- <sup>O</sup>  $PI < 4$  or plots below "A" line.
- <sup>P</sup>  $PI$  plots on or above "A" line.
- <sup>Q</sup>  $PI$  plots below "A" line.



## DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Term	Description
<b>Unweathered</b>	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
<b>Slightly weathered</b>	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
<b>Moderately weathered</b>	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
<b>Highly weathered</b>	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
<b>Completely weathered</b>	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
<b>Residual soil</b>	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	Field Identification	Uniaxial Compressive Strength, psi (MPa)
<b>Extremely weak</b>	Indented by thumbnail	40-150 (0.3-1)
<b>Very weak</b>	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
<b>Weak rock</b>	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
<b>Medium strong</b>	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
<b>Strong rock</b>	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
<b>Very strong</b>	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
<b>Extremely strong</b>	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	Spacing	Description	Spacing
<b>Extremely close</b>	< ¼ in (<19 mm)	<b>Laminated</b>	< ½ in (<12 mm)
<b>Very close</b>	¾ in – 2-1/2 in (19 - 60 mm)	<b>Very thin</b>	½ in – 2 in (12 – 50 mm)
<b>Close</b>	2-1/2 in – 8 in (60 – 200 mm)	<b>Thin</b>	2 in – 1 ft. (50 – 300 mm)
<b>Moderate</b>	8 in – 2 ft. (200 – 600 mm)	<b>Medium</b>	1 ft. – 3 ft. (300 – 900 mm)
<b>Wide</b>	2 ft. – 6 ft. (600 mm – 2.0 m)	<b>Thick</b>	3 ft. – 10 ft. (900 mm – 3 m)
<b>Very Wide</b>	6 ft. – 20 ft. (2.0 – 6 m)	<b>Massive</b>	> 10 ft. (3 m)

**Discontinuity Orientation (Angle):** Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) <sup>1</sup>	
Description	RQD Value (%)
<b>Very Poor</b>	0 - 25
<b>Poor</b>	25 - 50
<b>Fair</b>	50 - 75
<b>Good</b>	75 - 90
<b>Excellent</b>	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009  
 Technical Manual for Design and Construction of Road Tunnels – Civil Elements

END OF APPENDIX A1.01



## APPENDIX B1.01 - RADIO EQUIPMENT ROOM - SCOPE OF WORK



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JUNE 4, 2023

**MO State Hwy Patrol – Scope of Work Version 1.0**

We have divided this up into an electrical section, mechanical section, owner section and general construction provisions section.

**The Electrical Contractor is required to:**

1. Furnish and install 480V input feed to the UPS system and terminate.
  - a. UPS requires a 300A, 80% rated, input circuit breaker. Reference product submittals for full details.
  - b. Furnish and install DC (pos/neg) cables + ground from UPS to qty (2) lithium ION battery cabinets.
  - c. Furnish and install overhead ladder tray for routing DC cable from UPS to battery cabinets.
  - d. Terminate DC cabling and ground for battery cabinets
  - e. Furnish and install 1" conduit from UPS to battery cabinet (1 only) for routing of factory furnished communication wire
  - f. EC to utilize compression style lugs only.
2. Furnish and install overhead receptacles for all rack PDU's (total qty of 22, 2 per rack). Receptacles to be L21-30R. Mount to overhead ladder rack (not furnished by CFT/Schneider).
3. Furnish and install power for each in-row cooling unit. Total quantity of four (4).
  - a. Each In-Row requires a 208V 15A single phase input circuit breaker.
4. Furnish and install power for each of the roof mounted condensers. Total quantity of four (4).
  - a. Each condenser unit requires a 480V, 3Ph, 40A feed.
5. Reference installation manual for electrical connection info
6. Be on-site for the start up and commissioning of the equipment. UPS will be 1 day and the cooling units are estimated at 2 days.
7. Furnish and install pathway and cable for communications wiring between condensing unit and indoor in-row unit. This comm cable shall be in accordance with the manufacturer requirements as detailed in the product data provided by Critical Facilities Technology. (18/6 Twisted-Shielded Wire)

**The Mechanical Contractor is required to:**

1. Receive, Hoist and set the Rooftop Condenser units.
2. Run discharge and Liquid Line piping between four (4) In-row units and Condensers. (See Installation Manual for recommended sizing)

Page 1 of 7



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3. Mount and Install loosely shipped Flooded Receivers.
4. Run Condensate lines from four (4) In-Row units. Condensate pump is supplied internal to each unit. (See Installation Manual for recommended sizing)
5. Install Cooling Units per Installation Manual.
6. Furnish and charge with R410A Refrigerant.
7. Charge with PVE oil as required.
8. Pull a Vacuum down to 300 Microns on each unit for 2 hours. (Procedure in the Installation Manual)
9. Be on-site for the start up of the In-row Cooling units. Allocate one day of a qualified person per unit.
10. Schneider Electric recommends dampening pads be installed under the feet of the condensers per the installation manual.
11. Furnish and install communication as required to the existing building management system as required by the client.

**General Construction Considerations by Others:**

1. Installing Contractor shall furnish and install roof curbs and isolation pads for the condensing units as required by local and national code.
2. GC shall provide in wall backing for the wall ledger to support the containment panels
3. GC shall install the factory provided wall ledger to the wall by fastening to the, GC furnished, in-wall backing.
4. Mounting of the 2-post racks to the floor in the server room and installing the vertical cable organizers
5. Work and tasks shall have appropriate safety measures taken and coordinated with appropriate parties. This is to include all contractors.

**The Owner is required to:**

1. Supply and connect all CAT cables to the data center devices for integration with Struxureware Appliance.
2. Provide Static IP Address for Struxureware Appliance.
3. Provide access to required areas to all contractors.
4. Coordinate with appropriate internal parties for any service impacts that may occur during the installation of equipment. Examples of this would be power outages/downtimes, mechanical system outages/downtime and limited access requirements due to safety considerations.



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**CFT & SCHNEIDER ELECTRIC WILL PROVIDE THE FOLLOWING:**

1. Furnish equipment as outlined in the bill of material below.
2. Provide labor to “assemble” the server room pod. This work includes:
  - a. Moving the racks and cooling units into the room and “baying” them to one another.
  - b. Leveling the racks
  - c. Installing the hot air containment system.
  - d. Mounting of rack PDU’s
3. Labor to install the batteries in the two (2) battery cabinets
4. Startup of the UPS system
5. Startup of the four (4) in-row cooling units.
6. Overview training on the equipment.
7. Site project management services.

**BILL OF MATERIAL**

Quantity	Item	Description
1	GVSUPS150KGS	Galaxy VS 150kW 480V for external batteries, Start-up 5x8
1	GVSOPT001	Galaxy VS Air Filter Kit for 521mm wide UPS
1	GVSBPOT150	Galaxy VS Maintenance Bypass Cabinet with Output Transformer 150kW 480V In, 208V Out
1	GVSOPT038	Galaxy VS Live Swap Upgrade Kit for UPS with External Batteries
2	LIBSESMG16UL	Galaxy Lithium-ion Battery Cabinet UL with 16 x 2.04 kWh battery modules
1	WUPGEAA-UG-02	1 Yr EAA Prevent Srvc Upgrade to FW or Existing Srvc Plan for (1) 3P UPS 41 to 150KVA
1	WASSEMEXBAT-LB-02	(1) Assembly Service for (2) Cabinets Li-Ion Battery solution
1	WSTRTUP-LB-02	(1) Startup Service for (2) Cabinets Li-Ion Battery solution



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Quantity	Item	Description
1	QWPRJ-COORD	Site Coordination Services

Quantity	Item	Description
8	AR3307	APC NetShelter SX, Server Rack Enclosure, 48U, Black, 2258H x 600W x 1200D mm
1	AR3347	APC NetShelter SX, Networking Rack Enclosure, 48U, Black, 2258H x 750W x 1200D mm
18	AP8865	APC Rack PDU, 2G, metered, 0U, 8.6kW, 208V, 36 C13, 6 C19, and 2 NEMA 5-20R sockets
10	AR8561	APC NetShelter Cable Management, Cable Trough, Black, 597 x 191.4 x 317.4 mm
1	AR8571	APC NetShelter Cable Management, Cable Trough, Black, 747 x 191.4 x 317.4 mm
4	AR8580	APC NetShelter Cable Management, Cable Trough, Open Bottom, Black, 297 x 183.6 x 316.2 mm
2	AR8190BLK	APC NetShelter Cable Management, Third Party Rack Trough and Partition Adapter, Black, 580 x 510 x 800 mm
10	AR8162ABLK	APC NetShelter Cable Management, Data Cable Partition, Black, 579 x 122 x 71 mm
10	AR8163ABLK	APC NetShelter Cable Management, Data Cable Partition, Pass Through, Black, 579 x 122 x 71 mm
1	AR8172BLK	APC NetShelter Cable Management, Data Cable Partition, Black, 747 x 122 x 72 mm
1	AR8173BLK	APC NetShelter Cable Management, Data Cable Partition, Pass Through, Black, 747 x 122 x 72 mm



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Quantity	Item	Description
4	ACAC10005	InRow Bridge Partition, Data Cable 300 MM
4	ACRD301S	InRow DX 300mm 30kW
4	NBES0308	NetBotz Leak Rope Sensor - 20 ft.
4	ACCU301	InRow 30kW Condensing Unit, 480V, Single feed
4	ACAC10037	Ball Valve & Union
4	ACAC10049	Winter Accessory Kit - Heaters, Brackets, Wiring
4	ACAC75016	Flooded Receiver, 20L, 219mm diameter, 640mm length, ASME with 200w heater
4	ACDC2512	APC NetShelter Aisle Containment, Roof Height Adapter, 300 mm, for 42U to 48U SX
1	ACDC2000	APC NetShelter Aisle Containment, Ceiling Panel Mounting Rail, 1800 mm
4	ACDC2550	APC NetShelter Aisle Containment, Depth Adapter, 300 mm, for 1070 to 1200 mm 42U SX
2	ACDC2001	APC NetShelter Aisle Containment, Ceiling Panel Mounting Rail, 600mm
1	ACDC2002	APC NetShelter Aisle Containment, Ceiling Panel Mounting Rail, 300mm
1	ACDC2003	APC NetShelter Aisle Containment, Ceiling Panel Mounting Rail, 100mm
4	ACDC2004	APC NetShelter Aisle Containment, Ceiling Panel Wall Mount, Single Row, 1800 mm
12	ACDC2100	APC NetShelter Aisle Containment, Ceiling Panel, 900 mm
3	ACDC2015	APC NetShelter Aisle Containment, Ceiling Panel Lock System, without Power Supply



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Quantity	Item	Description
1	ACDC2017	APC NetShelter Aisle Containment, Ceiling Panel Lock System, 200 to 240V, with Power Supply
1	ACDC2018	APC NetShelter Aisle Containment, Aisle Containment Lighting Kit, with Power Supply
1	ACAC11009	InRow OA End Aisle Containment Kit - 48U
1	ACDC2410	APC NetShelter Aisle Containment, Curtain Door Mounting Rail, 900 to 1200 mm Aisle Width
1	AP9335TH	APC Temperature & Humidity Sensor
1	SFTWES50-DIGI	Ecostruxure IT Expert Access for 50 nodes
18	WUPGEAA-UG-01	1Yr EAA Prev Srvc Upgrd to FW or Exstng Srvc Plan - (1) 1or3P UPS 10 - 40kVA, Batt Frm, PDU or Acc.
4	WUPGEAA-AX-00	1 Yr EAA Prevent Srvc Upgrade to FW or Existing Srvc Plan for (1) In Row Cooling Unit
1	WNSC05	IT Expert OnSite Configuration
4	WSTRTUP5X8-AX-34	Start-up Service 5X8 for (1) In Row ACRD 300 and 301 series
4	WASSEM5X8-AX-34	Scheduled Assembly Service 5X8 for InRow ACRD 300 and 301 Series
1	WASSEM5X8-AX-20	Scheduled Assembly of the Hot Aisle Enclosure Kit specific components 10-14 Frames
8	WASSEM5X8-AX-21	(1) Assembly Service per Rack or InRow Air Containment component position front or back
2	WASSEM5X8-3R-PX-10	5X8 Scheduled Assembly of 1-3 Additional Racks
1	WASSEM5X8-5R-PX-20	5X8 Scheduled Assembly Service for 1-5 Racks
2	AR201	NetShelter 2 Post Rack 45U #12-24 Threaded Holes Black



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4	AP8865	APC Rack PDU, 2G, metered, 0U, 8.6kW, 208V, 36 C13, 6 C19, and 2 NEMA 5-20R sockets
18	AR8442	APC NetShelter Cable Management, Vertical Cable Manager, Cable Rings, Set of 8, Black, 55 x 766 x 85 mm
3	AR8625	Performance, Vertical Cable Manager for 2 & 4 Post Racks, 84"H x 6"W, Double-Sided with Doors

END OF APPENDIX B1.01