PROJECT MANUAL

Upgrade Generator Controls & Transfer Switch

Moberly Correctional Center

Moberly, Missouri

Designed By: Rogers-Schmidt Engineering Company
1736 West Park Center Drive, Suite 204
St. Louis, Missouri 63026

Date Issued: September 22, 2025

Project No.: C1920-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION

Facilities Management, Design and Construction

SECTION 000107A - PROFESSIONAL SEALS AND CERTIFICATIONS - GENERAL & ELECTRICAL

PROJECT NUMBER: C1920-01

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:

Certifications of Responsibility
The design professional whose personal seal and signature appear hereon, assumes responsibility only for what appears on the documents listed below and disclaims, pursuant to Missouri Code of State Regulations CSR 2030-3.060, any responsibility for any and all other plans, specifications, estimates, reports or other documents or instruments not sealed by the undersigned design professional relating to, or intended to be used for any part or parts of the project to which this refers.

Drawings:
G Series
ES, ED and E Series

Specifications:
Divisions 1, 26 and 33



Expires 12/31/2026
Barry D. Freiner, P.E.

END OF SECTION 000107A

SECTION 000107B - PROFESSIONAL SEALS AND CERTIFICATIONS – CIVIL, STRUCTURAL, & MECHANICAL

PROJECT NUMBER: C1920-01

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:

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Drawings:
M Series

Specifications:
Divisions 2, 3, 9, 10, 23, 31 and 32



Expires 12/31/2025
Christopher L. Barth, P.E.

END OF SECTION 000107B

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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 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:

	TITLE	SHEET #	DATE
1.	Cover Sheet	Sheet G-001	09-22-25
2.	Site Maps and Drawing Index	Sheet G-002	09-22-25
3.	Construction Limits, Schedule & Phasing	Sheet G-003	09-22-25
4.	Mechanical Symbols, Abbreviations & General Notes	Sheet M-001	09-22-25
5.	Mechanical Plan – Power Plant	Sheet MD-401	09-22-25
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16.	Electrical Site Plan	Sheet ES-101	09-22-25
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18.	One-Line Diagram – Demolition – 4.16kV	Sheet ED-601	09-22-25
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26.	One-Line Diagram – New Work – 4.16kV	Sheet E-602	09-22-25
27.	One-Line Diagram – New Work – 480V	Sheet E-603	09-22-25
28.	Panelboard Schedules	Sheet E-604	09-22-25

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. Upgrade Generator Controls & Transfer Switch
Moberly Correctional Center
Moberly, Missouri
Project No.: C1920-01

3.0 BIDS WILL BE RECEIVED:

A. Until: 1:30 PM, November 20, 2025

B. **Only electronic bids sent to FMDCBids@oa.mo.gov shall be accepted: (See Instructions to Bidders for further detail)**

4.0 DESCRIPTION:

A. Scope: The project consists of upgrading the existing diesel-engine-driven generator control system and transfer switch at the Moberly Correctional Center Power Plant including the associated supporting equipment and building modifications.

B. MBE/WBE/SDVE Goals: MBE 0%, WBE 0%, 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.**

5.0 PRE-BID MEETING:

A. Place/Time**:** 10:00 AM, October 28, 2025, at 5201 S. Worley, Moberly, Missouri, 65270 (meet at the Powerhouse building). Directions: After you cross the railroad tracks, stay straight on Martin Lane, then take a left on AA/Six Mile Lane for approximately 1/2-mile, Powerhouse will be on the left. 39.361588, -92.444182

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 $100.00** 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: Rogers-Schmidt Engineering Company, P.C., Barry Freiner, P.E., (636) 600-1551, email: BFreiner@Rogers-Schmidt.com

B. Project Manager: Scott Zeller, (573) 680-8138, email: Scott.Zeller@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.

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 one (1) party may be limited in accordance with available supply.

B. For the convenience of contractors, subcontractors and suppliers, bidding documents are available on the Owner's website at 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 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 successful Bidder (contractor) to fulfill every detail of the requirements of the contract, nor accepted as a basis for any claims for extra compensation or time extension.

B. Under no circumstances will Bidders give their plans and specifications to other Bidders. It is highly encouraged, but not required, that all Bidders be on the official planholders list to receive project updates including but not limited to any addenda that are issued during the bidding process.

4.0 - INTERPRETATIONS

A. No Bidder shall be entitled to rely on oral or written representations from any person as to the meaning of the plans and specifications or the acceptability of alternate products, materials, form or type of construction.

B. Bidders shall make all requests for interpretations in writing and submit all requests to the Project Designer and Project Manager identified in Section 007300 – Supplementary Conditions with all necessary supporting documentation no less than five (5) working days before opening of bids. Responses to requests for interpretation will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.

C. Bidders shall make all requests for an "Acceptable Substitution" on the Section 006325 Substitution Request Form. The request shall be emailed to the Project Designer and Project Manager identified in Section 007300 – Supplementary Conditions no less than five (5) working days before opening of bids. Responses to requests for substitutions will be issued via a written addendum and will be sent as promptly as is practicable to all official planholders and posted on the Owner's website. All such addenda shall become part of the bid and contract documents.

D. An "Acceptable Substitution" requested after the award of bid will only be approved if proven to the satisfaction of the Owner and the Designer 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 and all requests of this nature must be submitted in accordance with Article 3.1 of the General Conditions.

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 on the bid documents or the bid will be rejected for being non-responsive.

B. Depending on the specific project requirements, **the following is a GENERIC list** of all possible bid forms that may be due with bid submittals. Bidders must verify each specific project's requirements in Section 004113 to ensure they have provided all the required documentation with their submission.

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

C. The Bidder shall submit its bid on the forms provided by the Owner in the same file format (PDF) with each space fully and properly completed, typewritten or legibly printed, including all amounts required for alternate bids, unit prices, cost accounting data, etc. The Owner will reject bids that are not on the Owner's forms or that do not contain all requested information. All forms can be found on the Owner's website at https://oa.mo.gov/facilities/bid-opportunities/bid-listing-electronic-plans and shall be submitted with your bid to FMDCBids@oa.mo.gov.

D. All bids shall be submitted without additional terms and conditions, modifications, or reservations. The completed forms should not include interlineations, alterations, or erasures. Bids not in compliance with the requirements of this paragraph will be rejected as non-responsive.

E. 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 in the bid documents in Section 004113. Failure of the Bidder to submit the duly authorized bid bond or 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 bid closing or if the Bidder, within ten (10) working days after notification of award, refuses or is unable to 1) execute the tendered contract, 2) provide an acceptable performance and payment bond, or 3) provide evidence of required insurance coverage.

F. The bid bond 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.

6.0 - SIGNING OF BIDS

A. 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. If the Bidder is an entity organized in a state other than Missouri, the Bidder must provide a Certificate of Authority to do business in the State of Missouri.

B. If the successful Bidder is doing business in the State of Missouri under a fictitious name, the Bidder 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.

C. A bid from an individual shall be signed as noted on the Bid Form.

D. 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.

E. A bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.

F. A bid from a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation. Title of office held by the person signing for the corporation shall appear, along with typed name of said individual and the corporate license number shall be provided. In addition, for corporate proposals, the President or Vice-President listed per the current filing with the Missouri Secretary of State should sign as the Bidder. If the signatory is other than the corporate president or vice president, the bidder must provide satisfactory evidence that the signatory has the legal authority to bind the corporation.

7.0 - RECEIVING BID SUBMITTALS

A. It is the Bidder's sole responsibility to ensure receipt of the bid submittals by Owner on or before the date and time specified in the Invitation for Bid or as modified via written addenda. Bids received after the date and time specified will not be considered by the Owner.

B. All bids shall be received via email at FMDCBids@oa.mo.gov and bids received by the Owner through any other means, including hard copies, will not be considered, and will be discarded by the Owner unopened.

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

A. Bidder may withdraw a bid at any time prior to the 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. Bidder may modify a bid until the scheduled closing time by sending a revised bid to FMDCBids@oa.mo.gov with a note in the subject line and body of the email that it is a revised bid. All revised bids must be submitted to FMDCBids@oa.mo.gov, revised bids sent any other way will not be considered.

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 limited to, contracts for the furnishing and installation of furniture, equipment, machinery, appliances and other apparatuses.

C. The Owner will award a contract to the lowest, responsive, and 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 award shall be considered binding upon the Owner until the written contract has been properly executed and the following documentation has been provided: 1) performance and payment bond consistent with Article 6.1 of the General Conditions; 2) proof of the required insurance coverage; 3) an executed Section 004541 - Affidavit of Work Authorization form; and 4) documentation evidence enrollment and participation in a federal work authorization program.

F. Failure to execute and return the contract and associated documents within the prescribed period 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.

G. 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.

H. 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. Bidders must also submit an E-Verify Memorandum before the Owner may award a contract to the Bidder. Information regarding a E-Verify is located at https://www.e-verify.gov/employers/enrolling-in-e-verify. The contractor shall be responsible for ensuring that all subcontractors and suppliers associated with this contract enroll in E-Verify.

I. The successful Bidder must be registered in MissouriBUYS powered by MOVERS at https://missouribuys.mo.gov/supplier-registration# as an approved vendor prior to being issued a contract.

10.0 - CONTRACT SECURITY

A. The successful Bidder shall furnish a performance/payment bond as set forth in General Conditions Article 6.1 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, manufacturer, or suppliers 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. 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 or if more than one subcontractor is listed for any category without designating the portion of work to be performed by each, 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 Bidder'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. 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 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 required to complete and submit the applicable portion of Section 004545 - Anti-Discrimination Against Israel Act Certification with its 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.

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 nonresponsive, and its bid shall be rejected.

2. The Bidder should submit with its bid all 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 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 Prime Bidder that qualifies as an SDVE shall receive a three-percentage 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 will become 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.

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.) 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 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 Equal Opportunity or by the Federal U.S. Small Business Administration directory.

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 Office of Equal Opportunity online SDVE directory at https://oeo.mo.gov/sdve-certification-program/ or the Federal U.S. Small Business Administration directory https://veterans.certify.sba.gov/#search.

3. Additional information, clarifications, or other information regarding the MBE/WBE/SDVE listings in the directories may be obtained by contacting 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 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 granted a waiver and will be considered 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;

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 in the 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 nonresponsive 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 the 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 in writing.

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
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: **Upgrade Generator Controls & Transfer Switch**
Moberly Correctional Center
Moberly, Missouri

Project Number: **C1920-01**

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.

SAMPLE

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: $

Accepted Alternates, if applicable to the Project and accepted by the Owner.

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 0% MBE and 0% 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.

SAMPLE

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. Proposed Contractors Form (Section 004336)
        iii. MBE, WBE, SDVE Compliance Evaluation Form(s) (Section 004337)
        iv. MBE, WBE, SDVE Eligibility Determination Form for Joint Ventures (Section 004338)
        v. MBE, WBE, SDVE Good Faith Effort (GFE) Determination Form (Section 004339)
        vi. Missouri Service Disabled Veteran Business Form (Section 004340)
        vii. Affidavit of Work Authorization (Section 004541)
    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), if applicable
    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.

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

SAMPLE

Bond No._____

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

REASON FOR SUBSTITUTION

_____

_____

_____

_____

_____

_____

DOES PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK?

☐ YES ☐ NO

IF YES, EXPLAIN _____

_____

_____

_____

_____

_____

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:

_____

☐ Substitution is accepted.

☐ Substitution is accepted with the following comments:

_____

☐ Substitution is not accepted.

ARCHITECT/ENGINEER	DATE

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

FINAL RECEIPT OF PAYMENT AND RELEASE

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

TITLE

ORIGINAL: FILE/Closeout Documents

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

PAY APP NO.	PROJECT NUMBER
CHECK IF FINAL ☐**FINAL**	DATE

MBE/WBE/SDVE PROGRESS REPORT

Remit with **ALL** Progress and Final Payments

(Please check appropriate box) ☐CONSULTANT ☐CONSTRUCTION

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
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	
☐ MBE ☐ WBE ☐ SDVE	$	$	

Revised 06/2023

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

FILE: Closeout Documents

GENERAL CONDITIONS

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5. Construction and Completion

5.1. Construction Commencement

5.2. Project Construction

5.3. Project Completion

5.4. Payments

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

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. Acting by and through the Office of Administration, Division of Facilities Management, Design and Construction.
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"**: All supervision, labor, materials, tools, supplies, equipment, and any incidental operations and/or activities required by or reasonably inferable from the Contract Documents necessary to construct the Project and to produce the results intended by the Contract Documents 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 ensure 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 under this clause to any labor union with which they have bargaining or other agreements.

B. 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 ensure 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 subject to the following limits: (a) the percentage mark-up for the Contractor shall be limited to the Contractor’s fee: (b) fifteen percent (15%) maximum for Work directly performed by employees of a subcontractor, or sub-subcontractor; (c) five percent (5%) maximum for the Work performed or passed through to the Owner by the Contractor; (d) five percent (5%) maximum subcontractor’s mark-up for

Work performed by a sub-subcontractor and passed through to the Owner by the subcontractor and Contractor; and (e) in no case shall the total overhead and profit paid by the Owner on any Contract Changes exceed twenty-five percent (25%) 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 Contractor's payment and performance bonding, builder's risk insurance, and general liability insurance to their cost of work. The above listed bonding and insurance cost shall not exceed two percent (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(s) 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 the same as those for additive Contract Changes provided above.

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 <u>without</u> 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.

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 contact 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:
Barry Freiner, P.E.
Rogers-Schmidt Engineering Company, P.C.
1736 West Park Center Drive, Suite 204
St. Louis, Missouri 63026
Telephone: (636) 600-1551
Email: BFreiner@Rogers-Schmidt.com

Construction Representative:
Carl Haley
Division of Facilities Management, Design and Construction
301 W High Street, Room 730
Jefferson City, MO 65101
Telephone: (573) 645-7834
Email: Carl.Haley@oa.mo.gov

Project Manager:
Scott Zeller
Division of Facilities Management, Design and Construction
135 N. Chestnut
Jefferson City, Missouri 65101
Telephone: (573) 680-8138
Email: Scott.Zeller@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

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 5 complete sets of drawings and specifications at no charge.

B. The Owner will furnish the Contractor with approximately 5 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

MIKE KEHOE, Governor

Annual Wage Order No. 32

Section 088
RANDOLPH 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
Logan Hobbs, Director
Division of Labor Standards

Filed With Secretary of State: **March 10, 2025**

Last Date Objections May Be Filed: **April 9, 2025**

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$28.47*
Boilermaker	$28.47*
Bricklayer-Stone Mason	$28.47*
Carpenter	$53.67
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	$28.47*
Plasterer	
Communication Technician	$28.47*
Electrician (Inside Wireman)	$61.32
Electrician Outside Lineman	$28.47*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	$28.47*
Glazier	$28.47*
Ironworker	$28.47*
Laborer	$47.11
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	$28.47*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	$66.72
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	$28.47*
Plumber	$75.28
Pipe Fitter	
Roofer	$57.25
Sheet Metal Worker	$58.74
Sprinkler Fitter	$28.47*
Truck Driver	$28.47*
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
RANDOLPH County

Section 088

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$28.47*
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$28.47*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	$51.41
General Laborer	
Skilled Laborer	
Operating Engineer	$68.51
Group I	
Group II	
Group III	
Group IV	
Truck Driver	$28.47*
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 01 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of replacement of existing generator and transfer switch at the Moberly Correctional Center Power Plant.

1. Project Location: 5201 S Morley St., Moberly, Missouri 65270.

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 September 22, 2025, were prepared for the Project by Rogers-Schmidt Engineering Co., P.C., 1736 West Park Center Dr., Suite 204, St. Louis, Missouri 63026.

C. The Work consists of upgrading the existing diesel-engine-driven generator control system and transfer switch at the Moberly Correctional Center Power Plant including the associated supporting equipment and building modifications.

1. The Work includes, but is not limited to:

a. Demolition of the existing diesel-engine-driven generator's metal-enclosed switchgear and control panel, cooling water piping and remote radiator, and indoor day tank.

b. Demolition of three (3) existing panelboards, two (2) existing motor control centers, existing enclosed switches, combination motor starter, power feeder conduit and wiring, control circuit conduit and wiring, generator remote annunciator and branch and control circuit wiring.

c. Replacement of existing fuel oil supply and return piping from above grade fuel oil tanks to fuel oil pumps in Power Plant basement.

d. Relocation of existing outdoor metal-enclosed utility metering switchgear.

e. Relocation of existing Ameren Missouri substation fence at Power Plant.

f. Installation of new service entrance 4.16 kV fusible load-interrupter switchgear, 4.16 kV automatic transfer switch, 4.16kV generator connection cabinet, neutral grounding resistor, two (2) panelboards, one (1) motor control center, generator control panel, generator remote annunciator and associated power and control conduits and wiring.

g. New generator room ventilation system including fans, louvers, dampers and power and control conduits and wiring.

h. New outdoor remote radiator for the existing emergency generator, including associated piping, flow meter, power and control conduits and wiring.

i. New indoor fuel oil day tank with fuel return pumps, piping, unit mounted control panel, power and control conduits and wiring.

j. Modifications to existing building automation system to incorporate alarms and monitoring for new equipment including conduits and wiring.

k. Preventative maintenance service on the existing 4.16 kV outdoor metal-enclosed utility metering switchgear and 4.16 kV metal-enclosed fusible load-interrupter switchgear inside the Power Plant.

l. Protective device coordination study and arc flash risk assessment, including arc flash hazard warning labeling of new and existing electrical equipment at the Power Plant and within the facility.

m. Temporary emergency generator and 480V to 4.16 kV step-up transformer to provide emergency backup power for the facility while the existing permanent emergency generator is out of service for modifications.

D. The Work will be constructed under a single prime contract.

1.3 WORK SEQUENCE

A. The Work shall be conducted in accordance with the Construction Phasing & Scheduling indicated on Drawing G-003 – Construction Limits, Schedule & Phasing.

1. All Work shall be substantially complete, ready for occupancy within 360 working days of commencement of construction.

B. The Contractor shall provide a work sequence plan and schedule indicating phasing of work for review and approval by the Construction Representative prior to commencing with any of the Work.

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.

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.

C. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

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 01 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. 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 daily 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES

A. Weather Allowance: Included within the completion period for this Project are twenty (20) “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 01 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 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: Provide a medium-voltage fusible load-interrupter switch in accordance with Section 261316 – Medium-Voltage Fusible Load-Interrupter Switchgear on the load side of the

medium-voltage generator connection cabinet specified in Section 263290 – Medium-Voltage Generator Connection Cabinet as indicated on Drawings E-401 and E-601.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

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 substitutions.

B. Related Requirements:

1. Division 0, Section 006325 "Product Substitution Request" for the required form to be completed and submitted to request approval of a product substitution.
2. Division 1, Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. *Substitutions*: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. *Substitutions for Cause*: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. *Substitutions for Convenience*: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

A. *Substitution Requests*: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. *Substitution Request Form*: Use Owner provided form in Section 006325 – Product Substitution Request.
2. *Documentation*: Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
   b. Coordination information, including a list of changes or revisions needed to other parts of the Work that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of Designers and Owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. *Designer's Action*: If necessary, Designer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Designer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. *Forms of Acceptance*: Change Order, Construction Change Directive, or Designer's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Designer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. *Compatibility of Substitutions*: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. *Coordination*: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. *Substitutions for Cause*: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. *Conditions*: Designer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Designer will return requests without action, except to record noncompliance with these requirements:
    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Substitution request is fully documented and properly submitted.
    c. Requested substitution will not adversely affect Contractor's construction schedule.
    d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    e. Requested substitution is compatible with other portions of the Work.
    f. Requested substitution has been coordinated with other portions of the Work.
    g. Requested substitution provides specified warranty.
    h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. *Substitutions for Convenience*: Designer will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Designer.

1. *Conditions*: Designer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Designer will return requests without action, except to record noncompliance with these requirements:
    a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Designer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    b. Requested substitution does not require extensive revisions to the Contract Documents.
    c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    d. Substitution request is fully documented and properly submitted.
    e. Requested substitution will not adversely affect Contractor's construction schedule.
    f. Requested substitution has received necessary approvals of authorities having jurisdiction.
    g. Requested substitution is compatible with other portions of the Work.
    h. Requested substitution has been coordinated with other portions of the Work.
    i. Requested substitution provides specified warranty.
    j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 012500

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 01 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 0, Section 007213, Article 3.1 "Acceptable Substitutions" for administrative procedures for handling Requests for Substitutions made after Contract award.
2. Division 0, Section 007213, Article 4.0 "Changes in the Work" for Change Order requirements.
3. Division 1, Section 012100 "Allowances" for procedural requirements for handling and processing Allowances.
4. Division 1, Section 012200 "Unit Prices" for administrative requirements for using Unit Prices.
5. Division 1, Section 013115 “Project Management Communications” for administrative requirements for communications

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 Contactor 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 CONTRACT CHANGE 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 Applicable)

PART 3 - EXECUTION (Not Applicable)

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 01 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. Articles 1.8.B and 1.8.C of Section 007213 "General Conditions" for coordinating meetings onsite.
2. Article 5.4.H of Section 007213 "General Conditions" for coordinating Closeout of the Contract.
3. Division 1, Section 013200 "Schedules" for preparing and submitting Contractor's Construction Schedule.

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 Contract Changes

   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 Applicable)

PART 3 - EXECUTION (Not Applicable)

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 01 Specification Sections, apply to this Section.

B. Division 1, Section 012600 – Contract Modification Procedures

C. Division 1, Section 013300 – Submittals

1.2 SUMMARY

A. Project Management Communications: The Contractor shall use the Internet web-based project management communications tool, Trimble Unity Construct® (Formerly eBuilder) 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 Trimble Unity Construct® (Formerly eBuilder) as provided by "Trimble Unity Construct®" 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: Trimble Unity Construct® (Formerly eBuilder) 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/BIM files, processes or design information distributed in this system is intended only for the project specified herein.

D. Purpose: The intent of using Trimble Unity Construct®(Formerly eBuilder) 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 Trimble Unity Construct (Formerly eBuilder) 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.

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 Trimble Unity Construct® (Formerly eBuilder) 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 Trimble Unity Construct® (Formerly eBuilder) web site by licensed users.

a. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Subcontractors 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 Subcontractors 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 Subcontractors 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[1] 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[2] 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)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 013115

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

[2] 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 Trimble Unity Construct® (Formerly eBuilder) 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 and Division 01 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.

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, Designer, 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 01 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. Samples
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 01 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 24"x36".

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 SAMPLES

A. The Contractor shall comply with the General Conditions, Article 3.2.

B. The Contractor shall submit full-size, fully fabricated samples, cured and finished as specified, and physically identical with the material or product proposed. Samples 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 samples in a manner to facilitate review of qualities indicated. Prepare samples to match the Designer's sample including the following:

a. Specification Section number and reference

b. Generic description of the Sample

c. Sample source

d. Product name or name of the Manufacturer

e. Compliance with recognized standards

f. Availability and delivery time

2. The Contractor shall submit samples for review of size, kind, color, pattern, and texture. Submit samples 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 samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

c. Refer to other Sections for samples to be returned to the Contractor for incorporation in the Work. Such samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of sample submittals.

d. Samples 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 samples 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.

END OF SECTION 013300

SPEC SECTION	TITLE	CATEGORY
007213	List of Subcontractors	List of Subcontractors
007213	Major Material Suppliers	Major Material Suppliers
012500	Substitution Requests	Product Data
013100	Coordination - Coordination Drawings	Shop Drawings
013100	Coordination - Key Personnel Names	List of Subcontractors
013200	Schedules - Bar Chart	Construction Schedule
013200	Schedules - Bar Chart - Schedule of Values	Schedule of Values
013200	Schedules - Bar Chart - Schedule of Inspections and Tests	Construction Schedule
013300	Submittals - Record Drawings	As-Builts
013300	Submittals - Notifications & Permits	Certification
013300	Submittals - Quality Control	Certification
013300	Submittals - Inspection & Test Reports	Certification
013300	Submittals - Construction Photographs	Certification
013300	Submittals - O&M Manuals	Operation / Maintenance Manual
013513.16	Site Security and Health Requirements - MSDS	Product Data
013513.16	Site Security and Health Requirements - Schedule of Proposed Shutdowns	Construction Schedule
013513.16	Site Security and Health Requirements - Employee List for Security Clearances	Certification
013513.16	Site Security and Health Requirements - Employee Tuberculin Skin Test Results	Certification
016000	Product Requirements - Comparable Product Requests	Product Data
017823	Operation and Maintenance Manual	Operation / Maintenance Manual
024119	Selective Demolition	Construction Schedule
024119	Selective Demolition - Predemolition Photos	Certification
024119	Selective Demolition - Landfill Records	Certification
032000	Concrete Reinforcement	Shop Drawings
032000	Concrete Reinforcement	Product Data
032000	Concrete Reinforcement	Certification
033000	Cast-in-Place Concrete	Product Data
033000	Cast-in-Place Concrete	Shop Drawings
033000	Cast-in-Place Concrete	Certification
033000	Cast-in-Place Concrete	As-Builts
033000	Cast-in-Place Concrete	Test Report
099133	Painting	Product Data
099133	Painting	Sample
099133	Painting	Certification
099133	Painting	Test Report
104416	Fire Extinguishers	Product Data

SPEC SECTION	TITLE	CATEGORY
104416	Fire Extinguishers	Operation / Maintenance Manual
104416	Fire Extinguishers	Warranty
230505	Selective Demolition for HVAC	Construction Schedule
230505	Selective Demolition for HVAC- Predemolition Photographs	Product Data
230505	Selective Demolition for HVAC- Disposal Records - Hazard Waste	Certification
230523	General Duty Valves for HVAC Piping	Product Data
230523	General Duty Valves for HVAC Piping	Operation / Maintenance Manual
230529	Hangers and Supports for HVAC Piping and Equipment	Product Data
230529	Hangers and Supports for HVAC Piping and Equipment	Shop Drawings
230553	Identification for HVAC Piping and Equipment	Product Data
230553	Identification for HVAC Piping and Equipment	Sample
230593	Testing, Adjusting, and Balancing for HVAC	Certification
230593	Testing, Adjusting, and Balancing for HVAC	Test Report
230593	Testing, Adjusting, and Balancing for HVAC	Construction Schedule
230593	Testing, Adjusting, and Balancing for HVAC	Sample
230700	HVAC Insulation	Product Data
230900	Instrumentation and Control for HVAC	Product Data
230900	Instrumentation and Control for HVAC	Shop Drawings
230900	Instrumentation and Control for HVAC	Sample
230900	Instrumentation and Control for HVAC	Certification
230900	Instrumentation and Control for HVAC	Test Report
230900	Instrumentation and Control for HVAC	Warranty
230900	Instrumentation and Control for HVAC	As-Builts
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Product Data
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Shop Drawings
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Certification
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Test Report
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Operation / Maintenance Manual
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	Warranty
231113.10	Facility Fuel-Oil Piping - Secondary Containment Systems	As-Builts
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Product Data
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Shop Drawings
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Certification
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Operation / Maintenance Manual
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Test Report
231330	Fuel Oil Day Tank – Diesel Engine Driven Generator	Warranty

SPEC SECTION	TITLE	CATEGORY
232000	Piping for HVAC	Product Data
232000	Piping for HVAC	Certification
232000	Piping for HVAC	Test Report
232116	Piping Specialties	Product Data
232116	Piping Specialties	Shop Drawings
232116	Piping Specialties	Test Report
232116	Piping Specialties	Operation / Maintenance Manual
232116	Piping Specialties	Warranty
233100	HVAC Ducts and Casings	Shop Drawings
233100	HVAC Ducts and Casings	Product Data
233313.13	Volume-Control Dampers	Shop Drawings
233313.13	Volume-Control Dampers	Product Data
233313.13	Volume-Control Dampers	Warranty
233423	HVAC Power Ventilators	Shop Drawings
233423	HVAC Power Ventilators	Product Data
233423	HVAC Power Ventilators	Certification
233423	HVAC Power Ventilators	Test Report
233423	HVAC Power Ventilators	Operation / Maintenance Manual
233423	HVAC Power Ventilators	Warranty
235750	Remote Radiator – Diesel Engine Driven Generator	Shop Drawings
235750	Remote Radiator – Diesel Engine Driven Generator	Product Data
235750	Remote Radiator – Diesel Engine Driven Generator	Certification
235750	Remote Radiator – Diesel Engine Driven Generator	Test Report
235750	Remote Radiator – Diesel Engine Driven Generator	Operation / Maintenance Manual
235750	Remote Radiator – Diesel Engine Driven Generator	Warranty
260115	Preventative Maintenance for 4.16kV Electrical Equipment	Certification
260115	Preventative Maintenance for 4.16kV Electrical Equipment	Test Report
260505	Selective Demolition for Electrical - Schedule of Selective Demolition Activities	Construction Schedule
260505	Selective Demolition for Electrical - Inventory of Items to be Salvaged	Product Data
260505	Selective Demolition for Electrical - Predemolition Photographs	Product Data
260505	Selective Demolition for Electrical - Disposal Records - Hazardous Waste	Certification
260513	Medium-Voltage Cables - Product Data Sheets	Product Data
260513	Medium-Voltage Cables - Qualification Data for MV Cable Splice & Termination Installer	Certification
260513	Medium-Voltage Cables - Qualification Data for MV Cable Acceptance Testing Technician	Certification
260513	Medium-Voltage Cables - Preparatory & Acceptance Test Reports	Test Report
260519	Low-Voltage Electrical Power Conductors and Cables - Product Data Sheets	Product Data

SPEC SECTION	TITLE	CATEGORY
260519	Low-Voltage Electrical Power Conductors and Cables - Test Reports	Test Report
260526	Grounding and Bonding for Electrical Systems - Product Data Sheets	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Rod Resistance Test Report	Test Report
260529	Hangers and Supports for Electrical Equipment - Product Data Sheets	Product Data
260533.13	Conduit for Electrical Systems - Product Data Sheets	Product Data
260533.16	Boxes for Electrical Systems - Product Data Sheets	Product Data
260553	Identification for Electrical Systems - Product Data Sheets	Product Data
260553	Identification for Electrical Systems - Nameplate Engraving Schedule	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Software Certificates	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Study Specialist Qualifications	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Preliminary Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Final Report	Shop Drawings
260583	Wiring Connections - Product Data Sheets	Product Data
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - Descriptive Bulletins & Product Data Sheets	Product Data
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - Shop Drawings	Shop Drawings
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - For Record Submittals	As-Builts
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - Seismic Certificate	Certification
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - Certified Production Test Reports	Test Report
261316	Medium-Voltage Fusible Load-Interrupter Switchgear - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
261350	Neutral Grounding Resistor - Descriptive Bulletins & Product Data Sheets	Product Data
261350	Neutral Grounding Resistor - Shop Drawings	Shop Drawings
261350	Neutral Grounding Resistor - For Record Submittals	As-Builts
261350	Neutral Grounding Resistor - Seismic Certificate	Certification
261350	Neutral Grounding Resistor - Certified Production Test Reports	Test Report
261350	Neutral Grounding Resistor - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
262416	Panelboards - Descriptive Bulletins & Product Data Sheets	Product Data
262416	Panelboards - Shop Drawings	Shop Drawings
262416	Panelboards - Seismic Certificate	Certification
262416	Panelboards - SPD Test Reports	Test Report
262416	Panelboards - SPD Warranty Certificate	Warranty
262416	Panelboards - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
262419	Motor Control Centers - Descriptive Bulletins & Product Data Sheets	Product Data
262419	Motor Control Centers - Shop Drawings	Shop Drawings

SPEC SECTION	TITLE	CATEGORY
262419	Motor Control Centers - Seismic Certificate	Certification
262419	Motor Control Centers - For Record Submittals	As-Builts
262419	Motor Control Centers - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
262813	Fuses - Product Data for Each Type of Fuse	Product Data
262816.16	Enclosed Switches - Product Data Sheets	Product Data
262816.16	Enclosed Switches - Dimensioned Outline Drawings	Shop Drawings
262912	Motor Control - Product Data Sheets	Product Data
263213.16	Diesel-Engine-Driven Generator Set Controls - Product Data Sheets	Product Data
263213.16	Diesel-Engine-Driven Generator Set Controls - Shop Drawings	Shop Drawings
263213.16	Diesel-Engine-Driven Generator Set Controls - Warranty Certificate	Warranty
263213.16	Diesel-Engine-Driven Generator Set Controls - Field Technician Factory Training Certificates	Certification
263213.16	Diesel-Engine-Driven Generator Set Controls - Startup & Commissioning Test Reports	Test Report
263213.16	Diesel-Engine-Driven Generator Set Controls - Opeation & Maintenance Data	Operation / Maintenance Manual
263290*	Medium-Voltage Generator Connection Cabinet - Descriptive Bulletins & Product Data Sheets	Product Data
263290*	Medium-Voltage Generator Connection Cabinet - Shop Drawings	Shop Drawings
263290*	Medium-Voltage Generator Connection Cabinet - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
263623*	Medium-Voltage Automatic Transfer Switches - Descriptive Bulletins & Product Data Sheets	Product Data
263623*	Medium-Voltage Automatic Transfer Switches - Shop Drawings	Shop Drawings
263623*	Medium-Voltage Automatic Transfer Switches - For Record Submittals	As-Builts
263623*	Medium-Voltage Automatic Transfer Switches - Seismic Certificate	Certification
263623*	Medium-Voltage Automatic Transfer Switches - Certified Production Test Reports	Test Report
263623*	Medium-Voltage Automatic Transfer Switches - Installation, Operation & Maintenance Data	Operation / Maintenance Manual
311000	Site Clearing - Photographs	Product Data
311000	Site Clearing	As-Builts
312000	Earth Moving	Product Data
312000	Earth Moving	Certification
312000	Earth Moving	Test Report
315000	Excavation Support & Protection - Delegated Design	Product Data
315000	Excavation Support & Protection - Photographs	Product Data
315000	Excavation Support & Protection	As-Builts
321216	Asphaltic Paving	Product Data
321216	Asphaltic Paving	Certification
321216	Asphaltic Paving	Test Report
337119.13	Electrical Underground Ducts - Product Data Sheets	Product Data

*Spec Sections will be issued via Addendum.

SECTION 013513.16 – SITE SECURITY AND HEALTH REQUIREMENTS

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 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. Revise list to include all required submittals.
4. 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.
5. Tuberculin skin test results for all employees required to be tested as set forth below.

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. The Contractor shall provide Facility Representatives notice twenty-four (24) hours prior to any possible vehicle entry and/or required escort. The Contractor shall maintain a time log of any delays in gaining entrance to the Facility due to lack of an escort, which is to be submitted monthly with the Contractor's pay request materials. The purpose of this log is to establish a basis for a contract change, if required. The log shall contain the date and time of delay, date and time of request of entry, workers delayed (name and occupation), and name of the Facility Representative to whom the request was made, if possible. Any delay in entry must be validated by sallyport and pass office personnel at the Facility. Only delays greater than thirty (30) minutes will be considered for a contract change. A 30-minute delay upon arrival with a vehicle to enter the sallyport should be expected.

3.2 RULES OF THE FACILITY

A. The Contractor and its workers shall observe the following rules:

1. There shall be no fraternization with inmates.
2. No intoxicating beverages or illegal drugs shall be brought onto Facility grounds.
3. No firearms, other weapons, or explosives shall be carried onto Facility grounds.
4. No prescription drugs above one day's dosage shall be carried on Facility grounds.
5. Any vehicle or individual is subject to search at any time while on Facility grounds.
6. The vehicles of the Contractor and its workers shall be locked whenever unattended.
7. All tools and equipment shall be tightly secured during non-working hours in the Contractor's storage trailer or assigned area.
8. The Facility will not be responsible for the Contractor's tools, equipment, or materials. The Contractor shall keep and maintain a current tool inventory. The tool inventory shall be made available to Facility Representatives and the Owner upon request.
9. The Contractor shall report any missing tools to Facility Representatives immediately.
10. Smoking shall be permitted only in accordance with the regulations of the Facility.
11. Possession or use of smokeless tobacco or smokeless non-tobacco alternatives is strictly prohibited.

B. All workers shall be required to sign an acknowledgement of receipt of these rules.

3.3 SECURITY CLEARANCES AND RESTRICTIONS

A. DOC SECURITY CLEARANCE REQUIREMENTS

1. Prior to the commencement of any onsite work, the Contractor shall submit a list containing the name, date of birth, and Missouri driver's license number or social security number of all construction personnel to the Missouri Department of Corrections for the purpose of obtaining security clearances. The required information shall be submitted at the pre-construction meeting, or as otherwise directed by Department of Corrections' personnel. Any construction personnel with pending warrants or felony convictions within the last five (5) years or other offenses deemed to create a security risk by Department of Corrections shall not be allowed onsite. The Department of Corrections reserves the right to refuse admission to any individual they feel may be detrimental to the security of the Facility.

3.4 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. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

3.5 TUBERCULOSIS TESTING REQUIREMENTS

A. All workers who will be in the confines of the Facility for more than ten (10) consecutive working days must provide proof of a negative tuberculin skin test. The test results must be no more than six (6) months old at the commencement of construction. The Contractor or the worker, not the Owner, shall pay the cost of the test.

B. The Contractor shall submit to Facility Representatives current tuberculin skin test results for all workers who are required to have such a test in accordance with paragraph A above. If the contract period extends for more than twelve (12) months, the Contractor must provide new test results for all workers prior to the anniversary of the contract commencement date.

C. Any worker required to have a tuberculin skin test under paragraph A above who fails or refuses to do so will be denied admission to the facility until such time as proof of the test results are provided.

D. If any worker has a tuberculin skin test with positive results, the worker shall be denied access to the facility until the worker produces a certification from a physician licensed to practice in the State of Missouri that the worker does not have infectious tuberculosis.

E. The Contractor shall not be entitled to any additional time or compensation if any of its workers are denied access to the facility because of failure to produce negative tuberculin skin test results.

F. Failure or refusal of the Contractor to maintain and produce the required tuberculin skin test records shall be a material breach of this contract, which shall subject the Contractor to a declaration of default.

3.6 PREA FOR CONTRACTORS AND EMPLOYEES

A. The contractor and all of the contractor's employees and agents providing services in any Department of Corrections institution must be at least 18 years of age. A Missouri Uniform Law Enforcement System (MULES) check or other background investigation may be required on the contractor, the contractor's employees and agents before they are allowed entry into the institution. The contractor, its employees and agents understand and agree that the Department may complete criminal background records checks annually for the contractor and the contractor's employees and agents that have the potential to have contact with inmates.

B. The institution shall have the right to deny access into the institution for the contractor and any of the contractor's employees and agents for any reason, at the discretion of the institution.

C. The contractor, its employees and agents under active federal or state felony or misdemeanor supervision must receive written division director approval prior to providing services pursuant to a Department contract. Similarly, contractors/employees/agents with prior felony convictions and not under active supervision must receive written division director approval in advance.

D. The contractor, its employees and agents shall at all times observe and comply with all applicable state statutes, Department rules, regulations, guidelines, internal management policies and procedures, and general orders of the Department that are applicable, regarding operations and activities in and about all Department property. Furthermore, the contractor, its employees and agents, shall not obstruct the Department or any of its designated officials from performing their duties in response to court orders or in the maintenance of a secure and safe correctional environment. The contractor shall comply with the Department's policies and procedures relating to employee conduct.

1. The Department has a zero tolerance policy for any form of sexual misconduct to include staff/contractor/volunteer on offender, or offender on offender, sexual harassment, sexual assault, sexual abuse and consensual sex.

    a. Any contractor or contractor's employee or agent who witnesses any form of sexual misconduct must immediately report it to the warden of the institution. If a contractor or contractor's employee or agent fails to report or knowingly condones sexual harassment or sexual contact with or between offenders, the Department may cancel the contract, or at the Department's sole discretion, require the contractor to remove the employee/agent from providing services under the contract.

    b. Any contractor or contractor's employee or agent who engages in sexual abuse shall be prohibited from entering the institution and shall be reported to law enforcement agencies and licensing bodies, as appropriate.

E. The contractor, its employees and agents shall not interact with the offenders except as is necessary to perform the requirements of the contract. The contractor, its employees and agents shall not give anything to nor accept anything from the offenders except in the normal performance of the contract.

F. If any contractor or contractor's employee or agent is denied access into the institution for any reason or is denied approval to provide service to the Department for any reason stated herein, it shall not relieve the contractor of any requirements of the contract. If the contractor is unable to perform the requirements of the contract for any reason, the contractor shall be considered in breach.

3.7 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.

3.8 CELL PHONES AND ELECTRONIC DEVICES

A. Cell Phones, pagers, smart watches (that can send/receive messages), fitness wrist bands (that can send/receive messages) or other electronic devices are not permitted.

1. Contractors, repairpersons, or information technology services department staff may be permitted to bring in a cell phone and portable wireless router (Wi-Fi, MiFi, etc.) if approved by the Chief Administrative Officer (CAO) when the phone is necessary to complete job duties relating to repairs on a case by case basis.

2. Tablets (IPad, etc.) are not allowed with the exception of for re-entry purposes approved via the division of adult institutions (DAI) director and the re-entry manager.

3. Laptop computers may be permitted by the CAO on a case by case basis.

3.9 PROTECTION OF PERSONS AND PROPERTY

A. SAFETY PRECAUTIONS AND PROGRAMS

1. The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.

2. All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 292.675 RSMo.

3. In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner's Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner's Representative and Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner's Representative and the Contractor. “Rendered Harmless” shall mean that levels of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

B. SAFETY OF PERSONS AND PROPERTY

1. The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

   a. clients, staff, the public, construction personnel, and other persons who may be affected thereby;

   b. the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor's Subcontractors of any tier; and

   c. other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

2. The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.

3. The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.

4. When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.

5. The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in this Section caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under this Section, except damage or loss attributable solely to acts or omissions of Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing

obligations of the Contractor are in addition to the Contractor's other obligations stated elsewhere in the Contract.

6. The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner's Representative and Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its subcontractors of any tier.

7. The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.

8. The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.

9. The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the work, either by or against the Contractor.

10. The Owner assumes no responsibility or liability for the physical condition or safety of the Work site or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.

11. In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.

12. The Contractor shall maintain at his own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for clients, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

END OF SECTION 013513.16

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 01 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. Support facilities include, but are not limited to, the following:

1. Dewatering facilities and drains
2. Waste disposal services
3. Construction aids and miscellaneous services and facilities

C. Security and protection facilities include, but are not limited to, the following:

1. Temporary fire protection
2. Barricades, warning signs, and lights
3. Enclosure fence for the site excavations and construction areas
4. Environmental protection

1.3 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 Electrical Code”.

1.4 PROJECT CONDITIONS

A. 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:

1. For safety barriers and similar uses, provide minimum 5/8" (16mm) thick exterior plywood.

C. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less.

D. Open-Mesh Fencing: Provide open-mesh, orange plastic fencing with steel tee-posts driven into the earth at maximum intervals of 10-feet on center.

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. 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: Connect to existing services.

B. Temporary Water Service: The Owner will provide water for construction purposes from the existing building system. All required temporary extensions shall be provided and removed by the Contractor. Connection points and methods of connection shall be designated and approved by the Construction Representative.

C. Temporary Electric Power Service: The Owner will provide electric power for construction lighting and power tools. Contractors using such services shall pay all costs of temporary services, circuits, outlet, extensions, etc.

D. Temporary Heating and Cooling: The normal heating and/or cooling system of the building shall be maintained in operation during the construction. Should the Contractor find it necessary to interrupt the normal HVAC service to spaces, which have not been vacated for construction, such interruptions shall be pre-scheduled with the Construction Representative.

E. Temporary Telephones: Contractor's personnel will be permitted to use company cell phones outside the Facility security fence at the Power Plant.

F. Temporary Toilets: Use of the Owner's existing toilet facilities will be permitted, so long as facilities are cleaned and maintained in a condition acceptable to the Owner. All construction personnel will be allowed access only to those specific facilities designed by the Construction Representative. At substantial completion, restore these facilities to the condition prevalent at the time of initial use.

G. Wash Facilities: The Owner will provide wash facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

H. Drinking Water Facilities: The Owner will provide drinking water facilities within the building. All construction personnel will be allowed access only to those specific facilities designated by the Construction Representative.

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 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. Storage Facilities: Limited areas for storage of building materials are available onsite. Available storage areas are shown on the drawings. The Contractor shall provide his own security. Specific locations for storage and craning operations will be discussed at the Pre-Bid Meeting and the Pre-Construction Meeting.

C. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting. Under no circumstances will any vehicle be parked in a fire lane. Parking on lawns shall be prohibited.

D. 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.

E. 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.

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, stairways, 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. 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.

D. Enclosure Fence: Provide open-mesh, orange plastic fencing with steel tee-posts driven into the earth at maximum intervals of 10-feet on center at site excavations and construction areas.

E. 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. 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.
2. 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 016000 - PRODUCT REQUIREMENTS

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 selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Division 1, Section 012500 "Substitution Procedures" for requests for substitutions.
2. Division 1, Section 013300 “Submittals” for submittal requirements.
3. Refer to Division 26, Section 260500 “Common Work Results for Electrical”, Article 1.8 "Reference Standards" for applicable industry standards for products specified.

1.3 DEFINITIONS

A. *Products*: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. *Named Products*: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. *New Products*: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. *Comparable Product*: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. *Basis-of-Design Product Specification*: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. *Comparable Product Requests*: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.

2. *Designer's Action*: If necessary, Designer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Designer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

   a. *Form of Approval*: As specified in Division 1, Section 013300 "Submittals."

   b. Use product specified if Designer does not issue a decision on use of a comparable product request within time allocated.

3. Comparable product requests for products indicated in these specifications as “no substitutions” will not be considered.

B. *Basis-of-Design Product Specification Submittal*: Comply with requirements in Division 1, Section 013300 "Submittals." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. *Compatibility of Options*: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, Designer will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. *Delivery and Handling*:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. *Storage*:

1. Store products to allow for inspection and measurement of quantity or counting of units.

2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. *Manufacturer's Warranty*: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. *Special Warranty*: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. *Special Warranties*: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. *Manufacturer's Standard Form*: Modified to include Project-specific information and properly executed.

2. *Specified Form*: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.

3. See Divisions 2 through 26 Sections for specific content requirements and particular requirements for submitting special warranties.

C. *Submittal Time*: Comply with requirements in Division 0, Section 007213 "General Conditions."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. *General Product Requirements*: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. *Standard Products*: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Designer will make selection.

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

6. *Or Equal*: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or engineer approved equal", or "or designer approved equal", or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. *Product Selection Procedures*:

1. *Manufacturer/Source*: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

a. *Sole Source Items for This Project*:

1) Caterpillar/Fabick Power Systems: Controls upgrade to existing CAT 3516 diesel-engine-driven generator at the Power Plant.

2) Schneider Electric StruxureWare/C&C Group: Modifications to existing building automation system (BAS) at the Power Plant to connect new alarms and monitoring of new devices.

2. *Products*:

a. *Restricted List*: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

3. *Manufacturers*:

a. *Restricted List*: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

4. *Basis-of-Design Product*: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

2.2 COMPARABLE PRODUCTS

A. *Conditions for Consideration*: Designer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Designer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.

4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.

5. Samples, if requested.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 016000

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, oil, 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 impending 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.

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. Remove labels that are not permanent labels.

10. 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.

11. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

12. Clean plumbing fixtures to a sanitary condition free of stains, including stains resulting from water exposure.

13. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

14. Clean ducts, blowers, and coils if units were operated without filters during construction.

15. Leave the Project clean and ready for occupancy.

C. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.

D. 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 017823 - OPERATION AND MAINTENANCE DATA

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 administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation manuals for systems, subsystems, and equipment.
2. Systems and equipment maintenance manuals.

B. Related Requirements:

1. Division 0, Section 007213 “General Conditions”, Article 3.3 “As-Built Drawings”
2. Division 0, Section 007213 “General Conditions”, Article 3.5 “Operation and Maintenance Manuals”
3. Division 1, Section 013300 "Submittals" for submitting copies of operation and maintenance manual submittals
4. Divisions 2 through 33 Specification Sections for specific operation and maintenance manual requirements for the Work in those Sections

1.3 DEFINITIONS

A. *System*: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. *Subsystem*: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. *Operation and maintenance manual content*: See Division 0, Section 007213 “General Conditions”, Article 3.5 “Operation and Maintenance Manuals” and Division 0 through 33 Specification Sections. Submit manual content formatted and organized as required by this Section.

1. Designer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. *Format*: Submit operation and maintenance manuals in the following format:

1. *For Review and Comments*: PDF electronic file. Assemble each manual into a composite electronically indexed file. Upload the PDF file to the Missouri OA FMDC project management website, Trimble (fka eBuilder). Ensure all pages are oriented correctly for horizontal viewing.
2. *For Final Submission*:

a. PDF Electronic File uploaded to the Missouri OA FMDC project management website, Trimble (fka eBuilder). Ensure all pages are oriented correctly for horizontal viewing.

b. *Printed Hard Copies*: See Division 0, Section 007213 "General Conditions", Article 3.5 "Operation and Maintenance Manuals" for hard copy count and requirements.

C. *Manual Submittal*:

1. Submit manuals for review in a sufficient time before final submission is required as per Division 0, Section 007213 "General Conditions", Article 3.5 "Operation and Maintenance Manuals". Designer shall review submission and return copy with comments.

2. Correct or revise manual to comply with Designer's comments. Submit revised copy of manual for review.

3. *Final Submission*: See Division 0, Section 007213 "General Conditions", Article 3.5 "Operation and Maintenance Manuals" for requirements.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR OPERATION AND MAINTENANCE MANUALS

A. *Organization*: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page
2. Table of contents
3. Manual contents

B. *Title Page*: Include the following information:

1. Subject matter included in manual
2. Name and address of Project
3. Name and address of Owner
4. Date of submittal
5. Name and contact information for Contractor
6. Name and contact information for Designer
7. Names and contact information for major consultants to the Designer that designed the systems contained in the manuals
8. Cross-reference to related systems in other operation and maintenance manuals

C. *Table of Contents*: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include a comprehensive table of contents for all volumes in each volume of the set.

D. *Manual Contents*: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. *Manuals, Electronic Files*: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. *Electronic Files*: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. Ensure all pages are oriented correctly within the PDF file for horizontal viewing.

2.2 OPERATION MANUALS

A. *Content*: In addition to requirements in this Section, include operation data required in Division 0 through 33 Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria
3. Operating standards
4. Operating procedures
5. Operating logs
6. Wiring diagrams
7. Control diagrams
8. Precautions against improper use
9. License requirements including inspection and renewal dates

B. *Descriptions*: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name
3. Equipment identification with serial number of each component
4. Equipment function
5. Operating characteristics
6. Limiting conditions
7. Performance curves
8. Engineering data and tests
9. Complete nomenclature and number of replacement parts

C. *Operating Procedures*: Include the following, as applicable:

1. Startup procedures
2. Equipment or system break-in procedures

3. Routine and normal operating instructions
4. Regulation and control procedures
5. Instructions on stopping
6. Normal shutdown instructions
7. Seasonal and weekend operating instructions
8. Required sequences for electric or electronic systems
9. Special operating instructions and procedures

D. *Systems and Equipment Controls*: Describe the sequence of operation, and diagram controls as installed.

2.3 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. *Content*: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. *Source Information*: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. *Manufacturers' Maintenance Documentation*: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly
3. Identification and nomenclature of parts and components
4. List of items recommended to be stocked as spare parts

D. *Maintenance Procedures*: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions
2. Troubleshooting guide
3. Precautions against improper maintenance
4. Disassembly; component removal, repair, and replacement; and reassembly instructions
5. Aligning, adjusting, and checking instructions
6. Demonstration and training video recording, if available

E. *Maintenance and Service Schedules*: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. *Scheduled Maintenance and Service*: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.

2. *Maintenance and Service Record*: Include manufacturers' forms for recording maintenance.

F. *Spare Parts List and Source Information*: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. *Warranties and Bonds*: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. *Operation and Maintenance Manuals*: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

B. *Manufacturers' Data*: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

C. *Drawings*: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information noted on As-Built Drawings to ensure correct illustration of completed installation.

1. Do not use original project As-Built Drawings as part of operation and maintenance manuals.

2. Comply with requirements of Division 0, Section 007213 “General Conditions”, Article 3.3 “As-Built Drawings”.

END OF SECTION 017823

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 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 Designer.
    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. Upload to project site on Trimble (fka eBuilder).

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 Designer.

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. Designer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.

2. Owner will furnish an instructor to describe Owner's operational philosophy.

3. 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 024119 – SELECTIVE DEMOLITION

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 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all demolition work.

B. Work included in this Section includes all demolition work as shown on the Drawings and as specified herein and as required to complete the Work.

1.3 RELATED SECTIONS

A. Section 230505 – Selective Demolition for HVAC

B. Section 260505 – Selective Demolition for Electrical

1.4 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity, interruption of utility services, use of elevator and stairs, and locations of temporary partitions and means of egress.

B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations.

C. Landfill Records: If hazardous wastes are removed by contractor, indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.5 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

D. Prior to beginning demolition, arrange a conference with the Construction Representative to review demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.6 PROJECT CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Construction Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.8 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner’s property, demolished materials shall become the Contractor’s property and shall be removed from the site with further disposition at the Contractor’s option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner’s Representative and Engineer.

E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

F. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No demolition work shall be performed without prior approval of the Owner's Representative.

B. Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's plant.

C. Any demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

F. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

G. Unless noted otherwise, provide not less than two weeks notice to the Owner if shutdown of service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during demolition operations.

B. Provide dust control and ventilation as required in areas of demolition.

C. Execute demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas of building; maintain free and safe passage of persons around the areas of demolition.

D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the demolition work.

E. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

F. Protect existing surfaces, active utility services, and equipment which are to remain in place.

G. No blasting will be permitted.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's plant.

B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.

C. Areas of major demolition inside the Owner's plant shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the demolition work unless otherwise directed by the Owner's Representative.

3.6 DEMOLITION - GENERAL

A. Remove all work indicated on the drawings and as required to complete the new work indicated.

B. During demolition operations, keep areas adjacent to demolition work free of dust and debris.

C. During demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner’s Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to the building structural members so as to cut flush with but not damage the building structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

3.8 PIPING DEMOLITION

A. The Contractor shall use caution in the demolition of piping and shall inform himself of the conditions (fluid, pressure, temperature) of all piping systems to be demolished before making any cuts or breaking any joints.

B. Prior to breaking or cutting piping or tubing within the demolition area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be wrecked under this contract. Contact Owner's Representative for clarification prior to demolishing or wrecking questionable items.

C. Arrange for shutoff, isolation, and lock-out of piping with Owner’s Representative or utility companies.

D. When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

E. All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged or blind flanged.

3.9 ELECTRICAL DEMOLITION

A. See Section 260505 – Selective Demolition for Electrical in these Specifications.

3.10 PATCHING

A. All rough edges of openings created by demolition shall be promptly patched to create a finished surface.

B. Openings in concrete shall be patched with cement mortar.

C. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.11 REMOVED AND SALVAGED ITEMS

A. Clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area on-site designated by Owner.

E. Protect items from damage during transport and storage.

3.12 REMOVED AND REINSTALLED ITEMS

A. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

B. Pack or crate items after cleaning and repairing. Identify contents of containers.

C. Protect items from damage during transport and storage.

D. Reinstall items in locations indicated.

E. Comply with installation requirements for new materials and equipment.

F. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.13 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

B. When permitted by Owner’s Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.14 DISPOSAL

A. All debris resulting from demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not permitted.

D. Transport demolished materials off Owner’s property and dispose of legally.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.15 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to condition existing before selective demolition operations began.

3.16 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, does not believe that hazardous materials containing friable asbestos or lead based paint are included in the items to be demolished or the work areas.

B. Should the Contractor discover material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 024119

SECTION 031000 – CONCRETE FORMING 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. This section includes formwork for cast in-place concrete.

1.3 RELATED SECTIONS

A. Section 032000 – Concrete Reinforcement

B. Section 033000 – Cast-In Place Concrete

1.4 REFERENCES

A. ACI 117 - Tolerances for Concrete Construction and Materials.

B. ACI 301 Structural Concrete for Buildings.

C. ACI 318 Building Code Requirements for Reinforced Concrete.

D. ACI 347 Recommended Practice for Concrete Formwork.

E. AF&PA - National Design Specifications for Wood Construction.

F. ASTM D 1752 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

G. SPIB - 1994 Standard Grading Rules for Southern Pine Lumber (and Supplements).

H. WCLIB Rule No. 17 - Standard Grading and Dressing Rules.

1.5 DESIGN REQUIREMENTS

A. The design, engineering, and construction of all form work shall be the responsibility of Contractor.

B. Design, engineer, and construct formwork, shoring and bracing to conform to design and code requirements with resultant concrete conforming to required shape, line, and dimension.

C. All formwork shall be designed for the loads, lateral pressures, and allowable stresses outlined in ACI 347, “Recommended Practice for Concrete Formwork” and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 347, ACI 301 and ACI 318.

B. For wood products furnished for Work of this Section, comply with applicable provisions of AF&PA National Design Specifications for Wood Construction.

C. Maintain one copy of each document on site.

1.7 COORDINATION

A. Coordinate this Section with other sections of work, which require attachment of components to formwork.

B. Place formwork to obtain sufficient concrete cover over reinforcement.

C. Coordinate this Section with other sections of the work, which require application of finishes or waterproofing to formed concrete surfaces.

1. Verify that formwork and accessories are compatible with concrete finishes, coatings, waterproofing systems, etc.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Exposed Concrete: Unless otherwise shown or specified, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faces or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces.

B. Unexposed Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material.

C. Steel forms, if used, shall be flat and smooth, without dents, free of rust and shall be tight fitting for all exposed surfaces.

D. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

2.2 WOOD FORM MATERIALS

A. Lumber Forms: Use for edge forms and unexposed finish concrete. Boards shall be 6 inches or 8 inches in width, shiplapped or tongue and groove, “Standard” Grade Douglas Fir, conforming to WCLIB Standard Grading and Dressing Rule No. 17. Surface boards on four sides.

B. Plywood Forms: Use for exposed finish concrete. Forms shall conform to PS-1. Each panel shall carry the grade trademark of the APA/EWA and shall be full size 4-foot by 8-foot panels.

1. Plywood for surfaces to receive membrane waterproofing shall be a minimum of 5/8 inch thick and shall be APA “B-B Plyform Structural I Exterior” grade.

2. Plywood where “Smooth Finish” is required, as shown on Drawings, shall be “HD Overlay Plyform Structural I Exterior” grade, minimum of 3/4 inch thick.

2.3 PREFABRICATED FORMS

A. Manufacturers:

1. Aluma-Systems Inc., Burke Co.
2. Economy Forms Corp.
3. Molded Fiber Glass Concrete Forms Co.
4. Perma Tubes.
5. Sonoco Products Co.
6. Symons Corp.
7. Western Forms, Inc.

B. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Pan Type: Steel of size and profile required.

E. Steel Forms: Sheet steel, suitably reinforced, and designed for the particular use shown on Drawings.

F. Form Liners: Smooth, durable, grainless and non-staining hardboard, unless otherwise shown on Drawings.

G. Framing, Studding and Bracing: Stud or No. 3 structural light framing grade.

2.4 METAL FORM DECK

A. Metal deck shall be fabricated from high strength steel sheets conforming to ASTM A653 having a minimum yield strength of 80,000 psi.

B. Deck shall be minimum 20-gauge, box rib with paint grip ASTM A653/A924 galvanized finish.

C. Deck shall be placed with the ribs perpendicular to the supports and shall be continuous to the extent possible. End laps when required shall be a minimum of 2”. All sheets shall bear on concrete walls for 3” in accordance with the manufacturer’s erection standards.

D. Welding washers shall be furnished as required. Sheetmetal end closers shall be furnished and installed to prevent concrete leaking from the forms.

E. Deck shall be provided as required during concrete placing to limit maximum fiber stress to 30,000 psi and deflection to 1/240 of the span under the slab dead load plus a 20 psf construction load.

2.5 FORMWORK ACCESSORIES

A. Form accessories to be partially or wholly embedded in the concrete shall be of a suitable commercially manufactured type.

B. Form Ties: Removable type, metal, adjustable length, cone type with waterproofing washer.

1. Ties shall have no metal within 1" of finished surface.
2. Ties shall leave holes not less than 1/2" nor more than 1" in depth.
3. Ties shall leave holes no larger than 1" diameter in concrete surface.

C. Spreaders: Standard, noncorrosive metal form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face. No wire ties, wood spreaders or through bolts will be permitted.

D. In walls reinforced with epoxy coated bars, spreader bars shall be epoxy coated.

E. Proprietary combination bar clips and spreaders used in walls with epoxy coated reinforcing bars shall be made of corrosion-resistant material or coated with dielectric material.

F. Form Anchors and Hangers: Anchors and hangers used for exposed concrete shall not leave exposed metal at surface. Hangers supporting forms from structural steel shall be symmetrically arranged on supporting members to minimize twisting or rotation of member. Penetration of structural steel members will not be permitted.

G. Form Release Agent: Colorless non-staining agent which will not absorb moisture or impair natural bonding or color characteristics of waterproofing or coating intended for use on concrete.

H. Corners: Chamfer; 1 inch by 1-inch size; maximum possible lengths.

I. Waterproofing Membranes: Where shown on drawings, as specified in Division 7.

J. Joint Filler: ASTM D 1752.

K. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

L. Waterstops: Where shown on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with Drawings.

3.2 INSTALLATION

A. All footings and foundations shall be formed.

B. Pouring concrete against soil on the sides of the excavation will not be permitted unless shown on the Drawings.

C. Formwork - General: Sloped surfaces steeper than 1.5 horizontal to 1 vertical should be provided with a top form to hold the shape of the concrete during placement, unless it can be demonstrated that top forms can be omitted.

D. Construct forms to the correct shape and dimensions, mortar-tight, of sufficient strength, and so braced and tied together that movement of workers, equipment, materials, or the placing and vibrating of concrete shall not affect formwork and finished construction. Forms shall be strong enough to maintain their shape under all imposed loads.

E. Provide positive means of adjustment (wedges or jacks) of shores and struts.

F. Camber where necessary to assure level finished soffits unless otherwise shown on Drawings.

G. Verify horizontal and vertical positions of forms and correct inaccuracies before placing concrete in any form.

H. Complete wedging and bracing before placing concrete.

I. Take up all settlement during the concrete placing operations.

J. Forms for Surfaces to Receive Membrane Waterproofing: Use plywood or steel forms. After erection of forms, tape form joints to prevent protrusions in concrete.

K. Framing, Studding and Bracing: Space studs at 16 inches on center maximum for boards and 12 inches on center maximum for plywood.

1. Framing, bracing, centering, and supporting members shall be of adequate size and strength to carry safely, without deflection, all dead and live loads to which forms may be subjected and shall be spaced sufficiently close to prevent any bulging or sagging of forms.
2. of all beam forms shall be constructed of material a minimum of 2 inches thick.
3. bracing loads over base area on which bracing is erected.
4. When placed on ground, protect against undermining, settlement, or accidental impact.

L. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301.

M. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

N. Forms shall be constructed so that they can be removed without hammering or prying against concrete.

O. Obtain approval before framing openings in structural members that are not indicated on Drawings.

P. Provide chamfer strips on external corners of beams and pilasters.

Q. Do not reuse wood formwork more than 3 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.3 APPLICATION FORM RELEASE AGENT

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

C. Excess material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with concrete against which fresh concrete will be placed.

D. Do not apply form release agent where concrete surfaces will receive applied coverings such as a waterproof membrane that are affected by agent.

1. Soak inside surfaces of untreated forms with clean water.
2. Keep surfaces coated prior to placement of concrete.

E. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse.

1. For exposed work, do not reuse any form which cannot be reconditioned to "like new" condition.
2. Apply form coating to all forms in accordance with the manufacturer's specifications, except where "scored finish" is required as shown on the Drawings.
3. Do not coat forms for concrete that is to receive a "scored finish".
4. Apply form coatings before placing reinforcing steel.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required.

B. Accurately locate, set in place, and securely fasten items that will be cast directly into concrete.

C. Voids in sleeves, inserts, anchor slots, etc., shall be filled temporarily with readily removable material to prevent entry of concrete into the voids.

D. All embedded items shall be clean and free of oil and other foreign matter such as loose coatings of rust, paint, and scale. The embedding of wood in concrete shall be avoided except where specifically shown on the Drawings.

E. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

F. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.

G. Install waterstops continuous without displacing reinforcement. Heat seal joints watertight.

H. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

I. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

J. Form Ties: Use sufficient strength and sufficient quantity to prevent spreading of the forms. Place ties at least 1 inch away from the finished surface of the concrete.

1. Leave inner rods in concrete when forms are stripped.

2. Space all form ties to be equidistant, and symmetrical and lined up both vertically and horizontally unless otherwise shown on Drawings.

K. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

L. Construction Joints: Provide a surfaced pouring strip where construction joints intersect exposed surfaces to provide a straight line at joints. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage. Show no overlapping of construction joints, as closely as possible, to present the same appearance as butted plywood joints. Joints in a continuous line shall be straight, true, and sharp.

M. Embedded Items: Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features. No wood or uncoated aluminum shall be embedded in concrete. Obtain any required information pertaining to embedded items to be furnished for the work specified in other sections. Securely anchor all embedded items in correct location and alignment prior to placing concrete. Conduits and pipes, including those made of coated aluminum, must meet the requirements of ACI 318.

N. Openings for Items Passing Through Concrete: Frame openings in concrete where shown on the Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections. Coordinate all work of this nature in order that there shall be no unnecessary cutting and patching of concrete. Perform any cutting and repairing of concrete required as a result of failure to provide for such openings.

O. Screeds: Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs. Slope slabs to drain where required or as shown on the Drawings. Before depositing concrete, remove all debris from the space to be occupied by the concrete and thoroughly wet all forms. Remove freestanding water.

P. Screed Supports: For concrete over waterproof membranes and vapor barrier membranes, use screeds supports of a cradle, pad or base type which shall not puncture the membrane. Staking through the membrane will not be permitted.

Q. Cleanouts and Access Panels: Provide removable cleanout sections or access panels at the bottoms of all forms to permit inspection and effective cleaning of loose dirt, debris, and waste material. Clean all forms and surfaces against which concrete is to be placed of all chips, saw dust and other debris and thoroughly blow out with compressed air just before concrete is placed.

3.5 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.

B. Inspect erected formwork to ensure that work will provide a concrete surface suitable for exposure or for application of concrete finishes, coatings, waterproofing, etc.

C. Notify Owner's Representative after placement of reinforcing steel in the forms, but prior to placing concrete, so that inspection may be made.

3.6 FORM CLEANING

A. Clean forms as erection proceeds, to remove foreign matter within forms.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean out ports.

D. During cold weather, remove ice and snow from within forms. Do not use deicing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and the removal has been approved by Owner's Representative.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

D. Forms shall be left in place for not less than the total number of days as specified in ACI 347.

E. The Contractors registered engineer will determine the time and sequence of formwork and shoring removal for formwork supporting weight of concrete, such as beams, roof slabs, and self-supporting walls.

1. Contractor shall consider temperature, deadload, construction live loads, etc., in timing of formwork removal.

2. In any event, formwork supporting weight of concrete shall not be removed until concrete has reached compressive strength no less than 75% of the specified minimum 28-day compressive strength, and no sooner than seven (7) days.

3.8 ERECTION TOLERANCES

A. Formwork shall be constructed such that the finished concrete surfaces are free of any abrupt dimensional changes requiring extensive corrective work such as patching or grinding and that formed concrete will conform to dimensional tolerances as follows.

B. Construct formwork to maintain tolerances required by ACI 301.

C. Tolerances: Construct formwork so that concrete surfaces shall be within construction tolerances specified in ACI 117.

D. Above tolerances do not relieve Contractor from responsibility of adhering to closer tolerances where required to coordinate concrete work with work of various trades or to achieve special architectural details.

END OF SECTION 031000

SECTION 032000 – CONCRETE REINFORCING

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 SCOPE

A. The Contractor shall furnish and place reinforcing bars, stirrups, ties, bar supports, spacers, accessories, chairs, welded wire fabric, etc., as shown on the Drawings and as specified herein and as required to complete the work.

1.3 RELATED SECTIONS

A. Section 031000 – Concrete Forming and Accessories

B. Section 033000 – Cast-In-Place Concrete

1.4 QUALITY ASSURANCE

A. All work shall comply with provisions contained in the following documents (latest editions):

1. ACI 301 – Specifications for Structural Concrete
2. ACI 315 – Manual of Standard Practice for Detailing Reinforced Concrete Structures
3. ACI 318 – Building Code Requirements for Structural Concrete
4. ACI SP-66 – ACI Detailing Manual
5. CRSI – Manual of Standard Practice of the Concrete Reinforcing Steel Institute
6. ASTM A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
7. ASTM A 1035 – Standard Specification for Deformed and Plain Low-Carbon, Chromium Steel Bars for Concrete Reinforcement
8. ASTM A 185 – Standard Specification for Steel Welded Wire Reinforcements, Plain, for Concrete
9. ASTM A 775 – Standard Specification for Epoxy-Coated Steel Reinforcing Bars

1.5 SUBMITTALS

A. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, and supporting spacing devices.

B. Manufacturer’s Certificate: Certify that products meet or exceeded specified requirements.

C. Certified copies of mill test reports of reinforcement material analysis.

1.6 COORDINATION

A. Coordinate with placement of formwork, formed openings and other Work.

PART 2 - PRODUCTS

2.1 REINFORCING MATERIALS

A. The form and size of bars shall be as shown on the Drawings.

B. Reinforcing steel shall conform to ASTM A 615. Bars shall be Grade 60, unfinished unless noted otherwise.

C. If required, epoxy coated reinforcement shall conform to ASTM A 775.

D. Wire fabric for reinforcement shall conform to ASTM A 185. Wire fabric shall be furnished in flat sheets not rolls.

2.2 ACCESSORIES

A. Tie wire for unfinished reinforcement shall be minimum 16 gage, annealed type, epoxy coated.

B. Tie wire for epoxy coated reinforcement shall be plastic coated 16-gauge black annealed wire.

C. Provide spacers, chairs, bolsters, supports, and other devices to properly space and support reinforcing bars and welded wire fabric, which are compatible with the waterproofing system.

D. Use plastic tipped accessories at exposed surfaces.

E. Epoxy coated reinforcing bars supported from formwork shall rest on coated wire bar supports or on bar supports made of dielectric material or other acceptable materials.

1. Wire bar supports shall be coated with dielectric material, compatible with concrete, for a minimum distance of 2 inches from the point of contact with the epoxy coated reinforcing bars.
2. Reinforcing bars used as support bars shall be epoxy coated.
3. In walls reinforced with epoxy coated bars, spreader bars shall be epoxy coated.
4. Proprietary combination bar clips and spreaders used in walls with epoxy coated reinforcing bars shall be made of corrosion-resistant material or coated with dielectric material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Reinforcing steel shall be stored off the ground and protected from oil, or other deleterious materials. Epoxy coated reinforcing bars shall be stored on protective cribbing.

B. Clean oil, mud, loose rust and scale from reinforcing steel before concrete is placed.

C. Place in strict accordance with Drawings. Locate accurately in forms and hold firmly with approved supports and spacers to secure against displacement.

D. Use metal accessories to keep reinforcing clear distance from finish face of concrete surface as indicated on Drawings or required by applicable standards.

E. Do not displace or damage waterproofing membrane.

F. Accommodate placement of formed openings.

G. Cutting of bars shall be with mechanical saw only. Torch cutting will not be allowed.

H. Do not weld reinforcement unless noted on the Drawings.

I. Locate reinforcement splices not indicated on the Drawings, at point of minimum stress. Review location of splices with Engineer.

J. Any epoxy coated bars cut or welded such that coating is damaged shall be field coated with epoxy to match shop coat.

K. Coating damage to epoxy coated reinforcing bars due to handling, shipment, and placing need not be repaired where the damaged area is 0.1 square inches or smaller; damaged areas larger than 0.1 inches shall be field coated with epoxy to match shop coat. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the total surface area in each linear foot of the bar.

L. Provide supervision during placing of concrete to watch reinforcing and reset any bars displaced by pouring operation.

M. For welded wire fabric lap adjoining pieces one full mesh and lace splices with 16-gauge wire. Offset end laps in adjacent widths to prevent continuous laps.

N. The Contractor shall notify the Owner's Representative at least 36 hours before commencing to place concrete for any major portion of the work in order to permit inspection of the reinforcing.

END OF SECTION 032000

SECTION 033000 – CAST-IN-PLACE CONCRETE

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 SECTION INCLUDES

A. Cast-in-place concrete and accessories associated with concrete work.

1.3 RELATED SECTIONS

A. Section 031000 – Concrete Forming and Accessories

B. Section 032000 – Concrete Reinforcing

1.4 REFERENCES

A. ACI 301 – Structural Concrete for Buildings

B. ACI 302 – Concrete Floor and Slab Construction

C. ACI 304R – Measuring, Mixing, Transporting and Placing Concrete

D. ACI 305R – Hot Weather Concreting

E. ACI 306.1 – Cold Weather Concreting

F. ACI 308 – Curing Concrete

G. ACI 318 – Building Code Requirements for Structural Concrete and Commentary

H. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field

I. ASTM C 33 – Concrete Aggregates

J. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

K. ASTM C 94 – Ready-Mixed Concrete

L. ASTM C 150 – Portland Cement

M. ASTM C157 – Change of Hardened Hydraulic-Cement Mortar and Concrete

N. ASTM C 260 – Air Entraining Admixtures for Concrete

O. ASTM C 295 – Guide for Petrographic Examination of Aggregates for Concrete

P. ASTM C 309 – Liquid Membrane Forming Compounds for Curing Concrete

Q. ASTM C 457 – Microscopial Determination of Parameters of the Air-Void System in Hardened Concrete

R. ASTM C 494 – Chemicals Admixtures for Concrete

S. ASTM C 595M – Blended Hydraulic Cements (Metric)

T. ASTM C 618 – Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

U. ASTM C 989 – Ground Granulated Blast-Furnace Slag for use in Concrete and Mortar

V. ASTM D 994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type)

W. ASTM C 1017 – Chemical Admixtures for Use in Producing Flowing Concrete

X. ASTM C 1107 – Packaged Dry, Hydraulic Cement Grout (Nonshrink)

Y. ASTM C 1202 – Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

Z. ASTM C 1240 – Silica Fume Used in Cementitious Mixtures

AA. ASTM C 1260 – Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

BB. ASTM D 1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

CC. ASTM C 1567 – Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method)

DD. ASTM D 6690 – Concrete Joint Sealer, Hot-Poured Elastic Type

1.5 SUBMITTALS

A. Product Data: Submit data for bonding agent, joint devices, attachment accessories, form release agents, curing compounds, etc.

B. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent work.

C. Shop drawings for inserts.

D. Material Certificates: Submit mill certificates for the cement, supplementary cementitious materials, and admixtures intended for inclusion in the concrete mixtures.

1. Cement: Submit certification of compliance with ASTM C 150 for cement manufactured within 3 months of submittal date.

2. Fly Ash and Pozzolan: Submit certification of compliance with ASTM C 618 performed within 6 months of submittal date.

3. Ground Granulated Blast-Furnace Slag: Submit certification of compliance with ASTM C 989 performed within 6 months of submittal date.

4. Chemical Admixtures: Submit certificate of compliance with ASTM C 494 Level 1 or Level 2, performed within one year of the submittal date. If a chemical admixture does not fit into a defined C 494 type, admixture certificate shall provide documentation that the admixture has no detrimental effect on strength development, time of setting, shrinkage, air entrainment, scaling, and freeze-thaw resistance (ASTM C 666 Procedure A).

E. Project Record Documents:

1. Accurately record actual locations of embedded utilities and components that are concealed from view.

2. Submit upon request for record copies of all concrete delivery tickets.

3. Submit upon request for record copy of plan with locations and dates for concrete placements shown on drawing.

F. Aggregates: Submit test results for each aggregate intended for use in the concrete mixtures, showing conformance to ASTM C 33 and additional requirements as follows:

1. Aggregate source and identification

2. Maximum nominal aggregate size, gradation size number

3. Gradation analysis, including percentage retained and passing each sieve, and a graph of individual percentage retained versus sieve size

4. Quantity and identification of deleterious substances in the aggregates

a. The limits for deleterious materials contained in coarse aggregate as defined in ASTM C 33 – Table 3 Class 4S.

5. Submit complete data regarding concrete aggregates prior to any change in aggregate source.

G. Concrete Mixture Submittal: At least 30 days minimum prior to concrete placement, submit mixture proportions and prequalification test data for each type of concrete along with material certifications. Submit complete list of ingredients including type, brand, source, and amount of: cement, fly ash, ground-granulated blast-furnace slag, aggregates, and admixtures.

H. Construction Field Test Results: Fresh concrete properties, including slump, air content, temperature, and unit weight, and hardened concrete properties, such as strength, shall be measured and submitted for record.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Maintain one copy of each document on site.

C. Acquire cementitious materials and aggregate from same source contained in the submittals for all Work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306.1 when concreting during cold weather.

1.7 COORDINATION

A. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland cement shall conform to ASTM C-150, and shall be Type I. High Early Strength Cement, Type III may be used only when authorized by Owner's Representative.

B. Water shall be potable, clean, fresh, and free from oil, alkali, organic matter, or other impurities.

C. Fine aggregate shall be clean, coarse, washed river channel sand, free from loam, clay, lumps, or other deleterious material, conforming to ASTM C33 "Specifications for Concrete Aggregate".

D. Coarse aggregate shall be clean, hard, washed, and screened river gravel or clean, hard limestone free from dust, flat friable or laminated particles and fine materials. Aggregate shall conform to ASTM C33. Coarse aggregate shall be well graded from fine to coarse. Size of coarse aggregate shall not exceed 3/4".

E. Flint and chert will be limited to 1% maximum, by weight of the coarse aggregate, in all exposed concrete (cast-in-place or precast). Lignite will be limited to 0.07%, by weight of the fine aggregate in all exposed concrete.

2.2 ADMIXTURES

A. Air Entrainment: ASTM C 260

B. Chemical: ASTM C 494, Type A - Water Reducing, Type B – Retarding, Type C – Accelerating, Type F - Water Reducing, High Range. Calcium chloride or accelerating admixtures containing calcium chloride shall not be used.

C. Fly Ash and Calcined Pozzolan: ASTM C 618

D. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 80, 100 or 120

E. Plasticizing: ASTM C 1017

2.3 ACCESSORIES

A. Bonding Agent: Polymer resin emulsion or Latex emulsion.

B. Non-Shrink Grout: ASTM C 1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 pounds per square inch in 48 hours and 5,000 pounds per square inch in 28 days.

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler: ASTM D 1752; closed cell molded vinyl foam, resiliency recovery of 95 percent if not compressed more than 50 percent of original thickness.

B. Horizontal Joint Sealant: Multi-component Jet-Fuel-Resistant Urethane Sealant for Concrete - Pourable, chemically curing elastomeric formulation complying with the following requirements: Urethane Formulation - ASTM C-920, Type M; Grade P; Class 25; Uses T, M, A, and O as applicable to joint substrates indicated.

C. Vertical Joint Sealant: Multi-component Urethane Sealant for Concrete: Multi-component, gun grade urethane formulation complying with ASTM C 920 for Type M; Grade NS, Class 25, Uses T, M, and O as applicable to joint substrates indicated.

D. Joint-Sealant Backer Materials: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.

E. Backer Strips for Cold Applied Sealants: ASTM D 1751; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

F. Primers: Product 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.

2.5 CONCRETE MIX

A. Comply with the concrete proportioning and test requirements included in Paragraph 3.15.

B. Mix concrete in accordance with ACI 301. Deliver concrete in accordance with ASTM C 94.

C. Select proportions for normal weight concrete in accordance with ACI 301 trial mixtures.

D. Optimize the combined aggregate gradation to minimize the paste content required to make workable concrete.

E. Use accelerating admixtures in cold weather only when approved by Owner’s Representative. Use of admixtures will not relax cold weather placement requirements.

F. Admixtures containing ingredients corrosive to reinforcing steel such as chloride ion, bromide ion, or thiocyanate are not permitted.

G. Use set retarding admixtures during hot weather only when approved by the Owners Representative.

H. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

A. Prepare previously placed concrete surfaces by abrasive blast cleaning, to remove debris and laitance and expose aggregate. Thoroughly wet the substrate prior to placement of fresh concrete against prepared surface.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels in an approved grout, epoxy, or adhesive.

3.3 PROPORTIONING

A. Concrete shall be proportioned in accordance with ACI 211.1, "Standard Practice for Selecting Proportions for Normal and Heavyweight Concrete".

B. Provide a concrete mix having not less than the specified minimum 28 days compressive strength using Type I cement and a consistency that can be worked into corners and angles of the forms and around joints, waterstops, dowels, tie bars, and reinforcement without excessive spading or vibration, segregation or undue accumulation of water or laitance on the surface.

C. Concrete mixtures which have been designed, approved and tested shall be adjusted in the field from time to time when required to meet the varying conditions encountered during construction and to maintain the specified strength, air, and slump requirements. Only water reducing admixtures or super plastics may be added. Addition of water is <u>not</u> permitted.

D. The strength level of the concrete shall be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the compressive strength requirements specified and no individual strength test result falls below the specified compressive strength by more than 500 psi. Each compressive strength test result shall be determined by finding the average compressive strength of three cylinders tested at the age of 28 days.

3.4 MIXING

A. Only ready mixed concrete shall be used. Ready mixed concrete shall be mixed and transported to the job site in accordance with ASTM C94 "Specifications for Ready Mixed Concrete".

B. Discharge of the concrete from truck shall be completed within 90 minutes after the introduction of water to the cement. Discharge of concrete from a stationary truck body shall be within 45 minutes. The limitations above may be extended as approved by Owner's Representative if the concrete can be placed without addition of water to the batch to meet slump and placing requirements. In hot weather, or under conditions contributing to quick

stiffening of the concrete, the limitations above may be reduced as directed by Owner's Representative.

C. Any concrete developing a set before being placed or requiring additional water to restore its consistency shall not be used.

3.5 PLACING CONCRETE

A. Place and consolidate concrete in accordance with ACI 301 and ACI 318.

B. Notify Owner’s Representative and testing agency a minimum of 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, embedded parts, and formed expansion and contraction joints are not disturbed during concrete placement.

D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

E. Place concrete continuously between predetermined expansion, control, and construction joints.

F. Do not interrupt successive placement; do not permit cold joints to occur.

G. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit the installation of their work; cooperate with other trades in setting such work, as required.

H. Water, wood scraps, paper and all foreign material shall be removed from the place of deposit before concrete is poured.

I. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing.

J. While the concrete is being poured, it shall be spaded, tamped and vibrated so as to thoroughly work it around all reinforcement and embedded items and into corners of forms and leave a dense smooth surface when the forms are removed. Vibrators shall not be used to move or transport the concrete inside the forms.

K. Special precautions shall be taken to avoid segregation of the concrete during handling and placing operations. Concrete shall be deposited through suitable chutes or in such manner as to avoid a drop of more than 5' at any point.

L. Do not place concrete on frozen ground. Do not place concrete during rain, sleet, or snow unless adequate protection is provided and the Owner's Representative approves.

M. Walking on concrete shall not be permitted for at least 24 hours after it has been placed in the forms and for such additional hours thereafter as the Owner's Representative may direct.

3.6 HOT WEATHER PLACING

A. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided that the water equivalent of the ice is calculated to the total amount of mixing.

C. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

D. Wet forms thoroughly before placing concrete.

E. Do not use retarding admixtures unless otherwise accepted in mix designs.

3.7 COLD WEATHER PLACING

A. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures in compliance with ACI 306 and as herein specified.

B. When air temperature has fallen to, or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50°F and not more than 80°F, at point of placement.

C. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

D. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

3.8 CONCRETE FINISHING

A. Formed surfaces shall have the following finishes unless otherwise noted on the Drawings.

1. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work and not receiving waterproofing membrane. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

2. Smooth Form Finish: For formed concrete surfaces exposed to view, or that are to be covered with a coating, or covering material applied directly to the concrete, such as waterproofing, dampproofing, painting or other similar system. This is the as-cast concrete surface as obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed. Finish shall be Class A in accordance with ACI 347.

3. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and

plane and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise shown. Hand trowel tops of walls supporting precast concrete to a smooth, plane finish.

3.9 SLAB FINISHES

A. Slabs shall have following finishes unless otherwise noted on the Drawings:

1. Trowel Finish: Apply trowel finish to slab surfaces that are to be exposed to view and slab surfaces that are to be covered with resilient flooring, paint, or other thin film finish coating system. Surface plane tolerance shall not exceed 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

2. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete sidewalks, platforms, steps and ramps, equipment pads, and elsewhere as shown on Drawings. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route.

B. Seal all interior concrete slab surfaces to be left exposed with hardener applied in accordance with manufacturer's specifications.

3.10 CURING AND PROTECTION

A. 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.

C. Contractor shall have all equipment and material needed for curing and protection of the concrete on hand before actual concrete placement begins. The curing medium used shall be applied as soon as possible after placing to prevent checking and cracking and loss of moisture from all exposed surfaces of the concrete. Unhardened concrete shall be protected from heavy rains, flowing water, and mechanical injury (such as load stresses, heavy shocks, excessive vibration, and construction equipment, materials, or methods).

D. Concrete surfaces not in contact with forms shall be cured by one of the following methods:

1. Ponding or continuous sprinkling.

2. Application of absorptive mats or fabric kept continuously wet.

3. Application of waterproof sheet materials conforming to ASTM C171.

4. Application of a curing compound conforming to ASTM C309 in accordance with the recommendations of the manufacturer. Curing compounds shall be compatible with waterproofing system.

E. Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After removal of the forms the concrete shall be cured until the end of the curing period specified below by one of the methods specified above.

F. Curing shall be continued for at least 7 days in the case of all concrete except high-early-strength concrete for which the period shall be at least 3 days. Alternately, if tests are made on cylinders kept adjacent to the structure and cured by the same methods, curing may be terminated when the average compressive strength has reached 70% of the specified strength. The cost of molding and testing the cylinders to determine this time shall be borne by Contractor.

G. Cold Weather: When the mean daily outdoor temperature is less than 40°F, the temperature of the concrete shall be maintained between 50°F and 70°F for the required curing period specified above. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide. Contractor shall provide a temperature recording device indicating the high and low temperatures within the enclosure during the entire curing period.

H. Hot Weather: When conditions are such that the rate of evaporation is greater than the rate at which water rises to the surface of recently placed concrete (i.e., high concrete temperature, high air temperature, high wind, and low humidity, or combinations thereof), provision for wind breaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light-colored material shall be made in advance of placement to prevent plastic shrinkage cracking. Such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

I. Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during the curing period shall be kept as uniform as possible and shall not exceed 5°F per hour or 20°F in any 24-hour period. After the curing period, changes in air temperature adjacent to the concrete shall not exceed 5°F per hour or 50°F in any 24-hour period.

J. Remove any curing materials containing waxes or other products that may interfere with adhesion of waterproofing membranes or coatings.

3.11 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 by ACI certified technicians.

B. The Contractor will retain the services of a testing firm.

C. The Contractor shall be responsible for scheduling the tests.

D. Provide free access to Work and cooperate with appointed firm.

E. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.

F. Concrete for casting test specimens and fresh concrete properties shall be sampled at the end of the chute in accordance with ASTM C 172.

G. No water other than the incidental water used to prewet the delivery chute and fins shall be added to the concrete after the truck leaves the batch plant, unless directed in writing by the Owners Representative.

H. Adjustment of slump on site shall only be accomplished by the addition of water reducing or plasticizing admixture. Admixture shall be placed directly onto the concrete and the revolving drum mixer shall mix at high speed for 5 minutes, or 100 revolutions, before discharge.

3.12 TESTS DURING CONSTRUCTION

A. The following sampling and testing shall be provided by the Contractor using an independent testing laboratory.

B. Sampling and testing for quality control during the placement of concrete shall include the following:

1. Slump: ASTM C143; one test for each set of compressive strength test specimens.

2. Compression Test Specimen: ASTM C31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

3. Compressive Strength Tests: ASTM C39; one set for each 25 cu. yds. or fraction thereof, of each concrete class placed in any one day; one (1) specimen tested at 7 days, two (2) specimens tested at 28 days, and one (l) specimen retained in reserve for later testing if required.

4. Two additional test cylinders shall be cast during cold weather concreting and shall be cured on the job site under the same conditions as the concrete it represents. Compressive strength of field cured cylinders shall be determined prior to form removal, and at 56 days age.

C. Obtain concrete for casting test samples after slump adjustment.

D. Tests for fresh concrete properties (slump ASTM C 143, air content ASTM C 231, temperature ASTM C 1064, and unit weight ASTM C 138) shall be performed whenever casting test cylinders.

E. Additional fresh concrete property tests shall be performed when requested by the Owners Representative.

F. When the total quantity of a given class of concrete is less than 10 cu. yds., the strength test may be waived by the Owner's Representative if, in his judgement, adequate evidence of satisfactory strength is provided.

G. When the strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

H. Test results will be reported in writing to the Owner's Representative, Engineer, and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name, date of concrete placement, name of concrete

testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

I. The strength level of the concrete shall be considered satisfactory if the averages of all sets of three consecutive 28-day strength test results equal or exceed the compressive strength requirements specified and no individual strength test result falls below the specified compressive strength by more than 500 psi.

J. Concrete which fails to meet the minimum of 28-day strength requirements shall constitute questionable concrete. Contractor has the option of removing and replacing the questionable concrete or of making additional tests at his expense to prove the concrete strength is in compliance with the Specifications. Additional tests shall consist of core specimens taken where directed by Owner's Representative and in accordance with ASTM C42. Concrete in the area represented by the core tests will be considered adequate if the average of three cores is at least 85% of the compressive strength specified and if no single core is less than 75% of the required compressive strength. If core tests fail to meet the minimum strength requirements, or if tests are required from which it is impractical to secure core samples in accordance with ASTM C42, then load tests may be made in accordance with ACI 318 Part 6, Chapter 20 to determine acceptability. Cost of this testing shall be borne by Contractor.

K. Concrete work failing to meet minimum strength requirements as determined by additional tests shall be removed and replaced as directed by Owner's Representative at Contractor's expense.

3.13 INSERTS

A. Contractor shall provide all inserts and other cast-in-place items as shown and called for on the Drawings.

B. Steel plate and structural shapes shall be ASTM A36 and shall be shop cleaned and hot-dipped galvanized per ASTM A123 (minimum 2 oz/sq.ft.).

3.14 PATCHING

A. Allow Owner’s Representative to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Owner’s Representative upon discovery.

C. Repair surface defects immediately after form removal. Surface defects include color and texture irregularities, honeycomb, rock pockets, voids over 1/4" in any dimension, spalls, ridges, and stains or discoloration that cannot be removed by cleaning.

D. Clean and thoroughly dampen tie holes and fill with patching mortar.

E. Remove ridges, honeycomb, rock pockets, voids, etc., down to solid concrete. Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar or proprietary patching compound, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout, or proprietary bonding agent.

F. For surfaces exposed to view blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Compact mortar in place and strike-off slightly higher than surrounding surface.

G. If defects cannot be repaired, remove and replace concrete.

H. Use epoxy-based mortar for structural repairs.

I. Patch imperfections in accordance with ACI 301.

3.15 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.

B. Remedy for defective concrete (payment penalty, repair, or replacement) will be determined by Owner's Representative.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Owner's Representative for each individual area. Repairs made shall be in accordance with ACI 301.

3.16 SCHEDULE - CONCRETE TYPES AND TEST REQUIREMENTS

A. Concrete shall be Class A as specified on the following page.

Table 1 – Concrete Proportioning and Testing Requirements

Concrete Class	A
Materials and Proportions	
Cement, ASTM C 150	Type I/II
Supplementary Cementitious Materials, *cm*	50% max†
Maximum Aggregate Size	3/4 inch
Water-cementitious materials ratio, *w/cm*	0.40 max
Prequalification Requirements	
Aggregates	ASTM C 1260
Slump - ASTM C 143	6 to 8 in.
Chloride Content – ASTM C 1152	< 0.20% wt of cement
Air Content - ASTM C 231	6% +/- 1%
Hardened Air Content - ASTM C457	>6%
28-day Strength - ASTM C 39	4000 psi
Drying Shrinkage - ASTM C 157	Not Required
28-day Permeability – ASTM C 1202	Not Required
Permeability	
Field Testing for Process Control	
Slump - ASTM C 143	6 to 8 in. at point of placement
Air Content - ASTM C 231	6% to 8%
28-day Strength - ASTM C 39	4000 psi
28-day Permeability – ASTM C 1202	Not Required

† Maximum combined supplementary materials content of ternary or quaternary blends. Limitations on supplementary materials shall include quantities contained in blended cement. Fly ash content shall not exceed 25%. Ground granulated blast-furnace slag content shall not exceed 45%.

END OF SECTION 033000

SECTION 099133 – PAINTING – MEPF

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.

B. DESCRIPTION OF WORK

C. Furnish all materials, labor, equipment, and services necessary to perform painting and coating work.

D. Work included in this Section includes painting and coating of unfinished surfaces of mechanical, electrical, plumbing, and fire protection equipment and materials, except for those items specifically noted herein as not requiring painting.

1.2 SUBMITTALS

A. Product Data Sheets.

B. Color charts.

C. Qualifications.

D. Field Test Reports.

1.3 QUALITY ASSURANCE

A. Painting contractor shall have a minimum of five (5) years continuous experience and shall maintain a qualified staff of painters for the duration of the work.

B. Coatings shall be installed by contractors that have applied similar products at least twice in the last three (3) years.

1. Verification of such experience shall be provided by the Contractor prior to proceeding.

C. SSPC Standards:

1. Comply with SSPC Painting Manual, Volumes 1 and 2, latest edition.

D. Surface preparation and coating installation shall be in strict accordance with manufacturer's product data sheets, technical bulletins, and instructions.

E. Comply with the temperature and humidity requirements for proper application and curing of the coatings.

1. Provide temporary ventilation and/or heat if required for proper application and curing.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gallon of each material and color applied.

PART 2 - PRODUCTS

2.1 GENERAL

A. 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.

B. 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. Colors: As selected by Owner's Representative from manufacturer's full range.

1. Comply with facility's paint system when applicable.

D. Products specified herein are based on Sherwin-Williams products. Equivalent products by Tnemec or Porter are acceptable.

2.2 FILLING/FAIRING COMPOUND

A. A 100% solids, vertical surface, epoxy fairing compound, Sherwin-Williams Steel-Seam VSE, or approved equal.

2.3 COATINGS

A. Coatings shall be VOC compliant.

B. Paint System Type A:

1. Surface Preparation:
   a. Solvent cleaning per SSPC-SP1.
   b. Commercial blast cleaning per SSPC-SP6/NACE 3 to paint system manufacturer's recommended surface profile.
2. Prime Coat: Polyamide epoxy, organic zinc-rich primer, 300 F dry heat resistance, Sherwin Williams Zinc Clad IV, with dry film thickness of 3.0 to 5.0 mils.
3. Intermediate Coat: Surface tolerant, high solids, epoxy polyamide, 250 F dry heat resistance, Sherwin Williams Macropoxy 646, with dry film thickness of 3.0 to 10.0 mils.
4. Finish Coat: Acrylic polyurethane, 250 F dry heat resistance, Sherwin Williams Acrolon 7300, with dry film thickness of 2.0 to 4.0 mils.

C. Paint System Type B:

1. Surface Preparation:
   a. Solvent cleaning per SSPC-SP1.
   b. Hand tool clean to SSPC-SP2, or power tool clean to SSPS-SP3.
2. Prime Coat: Surface tolerant, high solids, epoxy polyamide, 250 F dry heat resistance, Sherwin Williams Macropoxy 646, with dry film thickness of 5.0 to 10.0 mils.
3. Finish Coat: Acrylic polyurethane, 250 F dry heat resistance, Sherwin Williams Acrolon 7300, with dry film thickness of 2.0 to 4.0 mils.

D. Paint System Type C:

1. Surface Preparation:
   a. Solvent cleaning per SSPC-SP1.
   b. Commercial blast cleaning per SSPC-SP6/NACE 3 to paint system manufacturer's recommended surface profile.
2. Prime Coat: Single component inert multipolymeric matrix coating, complying with NACE SP0198 CUI System CS-6 and SS-5, Sherwin Williams Heat-Flex Hi-Temp 1200 Coating Under Insulation, with dry film thickness of 5.0 to 6.0 mils.
3. Finish Coat: Single component inert multipolymeric matrix coating, complying with NACE SP0198 CUI System CS-6 and SS-5, Sherwin Williams Heat-Flex Hi-Temp 1200 Coating Under Insulation, with dry film thickness of 5.0 to 6.0 mils.

E. Paint System Type D:

1. Surface Preparation:
   a. Detergent cleaning to remove surface contamination.
   b. Lightly abrade the surface with fine grit sandpaper to dull surface.
2. Adhesion Test: Spot test paint system for acceptable adhesion prior to proceeding. Consult paint manufacturer to address adhesion issues, as required.
3. Prime Coat: Waterborne acrylic designed for coating hard, slick, glossy surfaces, Sherwin Williams Extreme Bond, with dry film thickness of 1.0 mil.
4. Intermediate Coat: High performance acrylic, Sherwin Williams Sher-Cryl HPA, with dry film thickness of 2.0 to 3.0 mils.
5. Finish Coat: High performance acrylic, Sherwin Williams Sher-Cryl HPA, with dry film thickness of 2.0 to 3.0 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate and confirm conditions are adequate for proper coating installation prior to proceeding.

B. Address deficiencies prior to proceeding.

3.2 COATINGS UNDER INSULATION

A. For coatings on surfaces to be insulated, field test and verify compatibility of coatings with insulation adhesives, mastics, caulks, etc. prior to proceeding.

1. Coordinate field testing with insulation contractor as required.
2. Proceed with coating application only if coating is confirmed acceptable by insulation contractor in writing.

3. Advise Engineer of any issues in writing of any issues prior to proceeding.

3.3 JOB CONDITIONS

A. Do not apply paint in snow, rain, fog, or mist; when the relative humidity exceeds 85 percent; at temperatures less than 5°F (3°C) above the dew point; to damp wet surfaces or in areas where dust is present.

B. Apply water based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50°F (10°C) and 90°F (32°C).

C. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45°F (7°C) and 95°F (35°C).

D. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

3.4 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations in “SSPC Painting Manual” applicable to substrates indicated.

B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

C. 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.

D. 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 the Owner’s Representative and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 SURFACE PREPARATION

A. Cover items which are not to be coated.

1. Do not paint members, or portions of members, to be embedded in concrete or mortar.

a. Paint embedded steel which is partially exposed on exposed portions and initial 2" of embedded areas only.

2. Do not paint surfaces which are to be welded or high-strength bolted with friction-type connections.
3. Do not paint surfaces which are scheduled to receive sprayed-on fireproofing.

B. Degrease surfaces with visual evidence of oily residue.

1. Biodegradable, organic solvents, alkaline solutions, steam, hot water with detergents or other systems that will completely remove dirt, oil, grease, etc. may be used.

C. Grind sharp edges to produce a smooth radius suitable for coating.

D. Remove imperfections such as shipping brace welds, delaminations, scabs, slivers and slag prior to high-pressure washing.

E. Prepare all surfaces for new paint systems in accordance with the manufacturer's instructions.

3.6 FILLING/FAIRING APPLICATION

A. Apply fairing compound to joints, grout plugs, and other surface irregularities to provide a smooth finish.

B. The compound shall be applied in accordance with the manufacturer's instructions.

3.7 COATING APPLICATION

A. Stripe coat any surface discontinuities, crevices, or sharp edges, etc.

B. Following stripe coat, apply a prime coat by brush, roller or spray to the dry film thickness indicated above.

C. Following prime coat, apply intermediate and top coats by brush, roller or spray to the dry film thickness indicated above.

3.8 FIELD QUALITY CONTROL & TESTING

A. Coordinate Owner's Representative inspection of field surface preparations prior to field painting.

B. Complete thickness testing and holiday, pinhole, and void detection of prime coat prior to proceeding with top coat.

C. Complete thickness testing and holiday, pinhole, and void detection of top coat.

D. All tests shall be done in the presence of the Owner's Representative and to his satisfaction.

E. Any areas that the tests reveal are inadequately or improperly coated shall be repaired by the Contractor at his expense and in such a manner so as to have the same integrity as the properly applied coatings.

3.9 CLEANING

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of coating carrying over to other areas.

B. During progress of work, remove from site discarded materials, rubbish, cans and rags at end of each work day.

C. Remove temporary protective wrappings, and clean any spattered surfaces.

D. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.10 DISPOSAL

A. Transport rubbish and materials off Owner's property and dispose of legally in accordance with Federal, State, and local laws and regulations.

3.11 FINAL TOUCH-UP

A. Prior to final completion of construction, clean and examine coating and repair any damage in accordance with manufacturer's instructions.

3.12 PAINT SCHEDULE

A. Surfaces to be Painted:

Surface Description	System	Paint Color
Supplemental Support Steel (for MEPF Systems)	B	Submit Color Charts
Carbon Steel Piping – No Insulation	A	Submit Color Charts
Carbon Steel Piping – Insulated	C	Submit Color Charts
PVC Piping	D	Submit Color Charts

Surfaces Not to be Painted:

1. Stainless steel, copper, or galvanized MEPF surfaces.

END OF SECTION 099133

SECTION 104416 – FIRE 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 SCOPE

A. Contractor shall furnish and install portable fire extinguishers as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Submit manufacturer's brochures and product data sheets.

B. Operating and maintenance manuals.

C. Warranty certificates.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10.

B. Fire Extinguishers: Listed and labeled by Underwriter’s Laboratory (UL) with UL listing mark for type, rating, and classification and Factory Mutual (FM) approved for type, rating, and classification.

1.5 WARRANTY

A. Provide manufacturer’s standard two-year warranty from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Ansul Inc.
2. Babcock-Davis
3. Kidde Residential and Commercial Division.
4. Larsen’s Manufacturing Co.
5. Nystrom, Inc.
6. Potter Roemer LLC.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: Carbon steel, complying with ASTM A1008/A1008M, commercial quality, stretcher leveled, temper rolled.

2.3 PORTABLE FIRE EXTINGUISHERS

A. General: Provide fire extinguishers of type, size, and capacity for each locations indicated on the drawings.

B. FE-1: A 20-lb, multi-purpose, UL listed, carbon dioxide fire extinguisher with a minimum rating of 10-B:C, with 3’ to 8’ range of stream, in manufacturer's standard enameled container.

C. FE-2: A 20-lb, multi-purpose, UL listed, dry chemical fire extinguisher with a minimum rating of 120-B:C, with 15’ to 21’ range of stream, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.

D. Mounting Brackets: Manufacturer’s standard steel bracket, designed to secure extinguisher, of sizes required for types and capacities of fire extinguisher indicated, with plated or baked-enamel finish.

2.4 FIRE EXTINGUISHER CABINETS – Not Required

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FIRE EXTINGUISHERS

A. Comply with manufacturer’s written instructions for installing fire extinguishers and mounting brackets.

B. Mounting Height: Install extinguishers at heights indicated below.

1. Install fire extinguishers mounted on hangers or brackets attached to a wall so that the top of the fire extinguisher is not more than 3½ ft. above the floor.
2. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 4 inches.

C. Locations: Install extinguishers at locations indicated below.

1. Install fire extinguishers at locations specified below:
   a. Inside emergency generator room within 5’ of exterior doors to emergency generator room.
   b. Outside emergency generator room, within 5’ of interior doors to emergency generator room.
2. Review location with the Owner’s Representative for approval prior to installing.
3. Fire extinguishers shall be conspicuously located, along normal paths of travel, including exits from areas.
4. Extinguishers shall not be obstructed or obscured from view.

D. Install portable fire extinguishers on the hanger or in the bracket supplied, or place in the fire extinguisher cabinets if provided. Verify that the extinguisher operating instructions face outward.

3.3 SIGNAGE

A. Identify bracket-mounted extinguishers with the words “FIRE EXTINGUISHER” in red letter decals applied to wall surface.

B. Application Process: Decals

C. Lettering Color: Red

D. Orientation: Vertical

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Provide protection and maintain conditions that ensure that fire extinguishers are without damage or deterioration at the time of Construction Completion.

END OF SECTION 104416

SECTION 230501 – GENERAL MECHANICAL REQUIREMENTS FOR HVAC

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 SCOPE

A. The requirements of this section are applicable to all work performed under Division 23 – Heating, Ventilating, and Air Conditioning (HVAC).

1.3 DESIGN LOADS

A. Outdoor mechanical systems, as well as the means of fastening to building structures and foundations, shall be capable of withstanding gravity, operating, wind, snow, ice, rain, and seismic loads.

B. Indoor mechanical systems, as well as the means of fastening to building structures and foundations, shall be capable of withstanding gravity, operating, and seismic loads.

C. The International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures (current editions) shall be used as the design basis with specific environmental factors as stated below.

D. Comply with the ASCE Hazards Report for the site included as Attachment 1 to Section 230501 – General Mechanical Requirements for HVAC.

E. Minimum Design Wind Speed: 120 mile per hour

F. Earthquake Design Data:

1. Occupancy Classifications:

   a. Power Plant: Moderate-hazard factory industrial, Group F-1
   b. Correctional Center: Institutional Group I-3, Condition 5

2. Risk Category: IV

3. Seismic Importance Factor: Ie = 1.5

4. Site Class: D

5. Mapped Spectral Response Accelerations: Ss = 0.23, S1 = 0.1

6. Spectral Response Coefficients: SDS = 0.2, SD1 = 0.14

7. Seismic Design Category: D

8. Component Amplification Factor: Ap = 2.5

9. Component Response Modification Factor: Rp = 2

10. Overstrength Factor: Ωo = 2

11. Analysis Procedure: Equivalent Lateral Force ASCE 7

1.4 COORDINATION

A. It is the intent of the Mechanical Division of these Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations shall operate as designed.

B. All systems shall be completely assembled, tested, adjusted, and demonstrated to be ready for operation to the satisfaction of the Owner's Representative.

C. The Contractor shall note that in some cases piping, ductwork and equipment as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference free systems with proper clearance to facilities and equipment.

D. The Contractor shall note that configuration and dimensions of equipment may vary from that shown on the Drawings depending on the equipment supplied. The Contractor shall be responsible for making the necessary modifications to connecting piping, ducts, bases, etc. required by the equipment supplied.

E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

1.5 SUBMITTALS

A. Submittals shall be furnished under this Division for approval in accordance with the procedures outlined in Division 1 and the separate sections of this Division.

B. Submittals shall include complete data including physical dimensions and other information required for installation as well as performance capabilities and limitations. Provide schedules indicating locations when more than one type of an item is to be used. All shop drawings must be certified as being correct for the proposed work.

C. Shop drawings, brochures or catalog cuts showing more than one size or model shall be marked to indicate the size or model proposed for the particular application.

D. Prior to submitting for approval, submittals shall be coordinated with the work of all other trades.

E. Submittals shall be identified as to the specific equipment for which the submittal relates. Identification shall be by reference to equipment numbers as shown on the Drawing or by reference to the appropriate Article of the Specifications in which the equipment is specified.

1.6 INSTRUCTION MANUALS

A. Instruction manuals shall be furnished to Owner's Representative prior to start-up. Manuals shall be bound with table of contents and tabs for each section. Each set is to include the following information for all equipment furnished:

1. Manufacturer's parts list identified with the make, model and serial number of the equipment furnished.
2. Schematic control, flow and wiring diagrams identifying the location and function of all system components, valves, and controls.
3. Installation, operation, lubrication, and maintenance instructions.
4. Manuals shall incorporate design basis, drawings, flow diagrams, brochures, and operating instruction in sufficient detail to enable operators to understand the equipment or system, its operation, limitations, and maintenance needs.

1.7 CODES AND STANDARDS

A. Governing federal, state, and local laws, codes and standards constitute minimum requirements and strict compliance therewith is required unless supplemented and/or modified by more stringent requirements of the Contract Documents.

B. Installation of HVAC systems and equipment shall comply with all applicable codes. These shall include the latest edition of the following:

1. International Mechanical Code
2. International Plumbing Code

C. All equipment, apparatus and systems shall be fabricated and installed in complete accordance with the latest edition or revision of the following applicable regulations, standards, and codes:

1. ANSI - American National Standards Institute
2. ARI - Air Conditioning and Refrigeration Institute
3. AABC - American Air Balance Council
4. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
5. ASME - American Society of Mechanical Engineers
6. ASSE - American Society of Sanitary Engineering
7. ASTM - American Society for Testing and Material
8. AMCA - Air Moving and Conditioning Association
9. AWS - American Welding Society
10. BOCA - Building Officials and Code Administrators
11. NFPA - National Fire Protection Association
12. IMC - International Mechanical Code
13. IPC - International Plumbing Code

14. NEC - National Electrical Code
15. NEMA - National Electric Manufacturers Association
16. NSF - National Sanitation Foundation
17. PDI - Plumbing and Drainage Institute
18. OSHA - Occupational Safety and Health Administration
19. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
20. UL - Underwriters Laboratories, Inc.

1.8 QUALITY STANDARDS

A. All materials and equipment furnished under these Specifications shall be new and to the extent possible, standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of the specific items is required, all shall be of the same type and manufacture.

B. The product of manufacturers shall be acceptable only when that product complies with or is modified as necessary to comply with all specified and indicated requirements in the Contract Documents.

C. Materials and equipment not herein specified or indicated as to manufacture but necessary for complete functioning systems shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. All equipment shall have factory applied permanent nameplates indicating the manufacturer's name, model and serial numbers, temperature and pressure design and any other data necessary to conform with specified requirements.

2.2 LIFTING ATTACHMENTS

A. All equipment requiring hoisting for installation and/or maintenance shall be provided with suitable lifting attachments by the manufacturer. Manufacturer's installation instructions shall detail correct lifting procedures to preclude equipment damage.

2.3 EQUIPMENT GUARDS

A. All rotating equipment including couplings, gear trains and belt drives shall be provided with adequate guards for personnel protection. Wherever possible, the guards shall be provided by the equipment manufacturer. The guards shall be supported to prevent vibration or interference with the rotating equipment and shall be removable. Guards shall conform to OSHA requirements.

2.4 EQUIPMENT PROTECTION

A. Equipment openings and connections shall be provided with adequate covers at the factory to protect the internals, threads and flanges and prevent entrance of any foreign matter prior to installation.

B. Exposed machined surfaces of equipment such as shafts, bearing surfaces, gasket surfaces, gears, etc., shall be provided with adequate protection at the factory to prevent physical damage and corrosion prior to installation.

2.5 PAINTING AND FINISHES

A. All purchased equipment shall have a factory applied standard finish of the manufacturer's standard color unless otherwise specified.

B. Finishes which are marred during shipping, handling or installation shall be touched up to match the original finish.

C. Shop and field fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed, be thoroughly cleaned of dirt, rust, weld slag, grease or oil and be painted in accordance with Division 9 as a requirement under this Division.

2.6 LUBRICATION AND TOOLS

A. Provide a fresh charge of lubricant in accordance with the manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by the Owner.

B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's Representative prior to final acceptance of the equipment.

2.7 GROUT

A. Unless otherwise required by the equipment manufacturer, grout shall be non-metallic, non-shrink type, with 5000 psi compressive strength at 28 days.

2.8 FIRE-RESISTANCE-RATED ASSEMBLY

A. Unless noted otherwise, provide UL, 2-hour, fire-resistant-rated penetrations through all walls and floors and ceilings.

PART 3 - EXECUTION

3.1 WORK VERIFICATION AND FIELD MEASUREMENTS

A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.

B. Location of all equipment and systems shall be coordinated to preclude interferences with other construction.

C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Owner's Representative shall be notified, and any changes approved before proceeding with the work.

3.2 PERMITS AND INSPECTIONS

A. Contractor shall be responsible for obtaining the required permits governing the work from authorities having jurisdiction and shall assume the cost of permits and inspections.

B. Upon completion of work, Contractor shall furnish to the Owner certificates of inspection or approval from the authorities having jurisdiction, if certificates of inspection or approval are required by law or regulations.

3.3 RECORD DRAWINGS

A. Contractor shall keep a written record of all deviations in location or elevation of piping and any underground or concealed installation from that shown on the Drawings. Records shall consist of clearly marked Drawings which shall be submitted to the Engineer after completion of construction.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial or flow line with reference to the finished ground floor elevation.

3.4 ACCESSIBILITY

A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting, or servicing of any kind.

3.5 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to approval by the Owner's Representative at all times.

B. Cutting, burning, drilling, welding, or the use of explosive driven fasteners on building structures shall require prior approval by the Owner's Representative for each type of application unless specifically shown on the Drawings.

C. Equipment or piping shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions unless specifically indicated on the Drawings.

3.6 THERMAL METAL JOINING AND CUTTING

A. All welding, brazing, soldering, and cutting work shall conform to applicable provisions of the following codes and requirements:

1. ASME Boiler and Pressure Vessel Code
2. American National Standards Institute (ANSI) B31.1 (latest), Power Piping and Addenda

3. American Welding Society (AWS) D1.1 (latest) Structural Welding Code

B. Welding shall be performed only by skilled welders.

C. Welders and welding procedures employed on pressure vessel or pressure piping work performed under the ASME/ANSI code shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code or with local codes where they take precedence. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job for code welding.

D. One certified copy of the qualification test for each welder so employed shall be furnished as a submittal.

E. Welders and welding procedures employed on structural steel pipe and equipment supports shall be qualified by tests in the "Standard Qualification Procedure" of the AWS.

F. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job.

G. Qualified weld procedures and one certified copy of the qualification test for each welder so employed shall be furnished as a submittal.

H. Welding electrode storage shall, at a minimum, comply with the requirements of AWS D1.1, ANSI B31.9, ASME Boiler and Pressure Vessel Code, or the electrode manufacturer, whichever is most stringent.

I. Contractor shall establish the proper quality control procedures and tests to ensure all welds shall comply with the applicable requirements of the codes referenced above.

J. The Contractor shall test all pipe welds for proper quality using nondestructive, ultrasonic testing procedures in accordance with the applicable ANSI/ASME codes.

1. Testing shall be completed by Contractor’s third party, certified weld inspector, subject to approval of Construction Representative.

K. Contractor shall complete any required repairs at Contractor’s cost.

L. All cutting residue shall be cleaned from the interior of pipes prior to welding or joining.

3.7 HOUSEKEEPING PADS AND ANCHOR BOLTS

A. Housekeeping pads shall be provided for all floor-mounted equipment. Unless otherwise shown, housekeeping pads shall be 4" high, 4000 psi concrete, with #4 reinforcing rods 12" on center each direction in center of pad.

B. The size and configuration of housekeeping pads and anchor bolt requirements shall be coordinated with and shall be suitable for the equipment to be installed. Contractor shall be responsible for coordinating all requirements prior to forming and pouring the pad.

C. Existing floor surface shall be roughened, or epoxy binder applied prior to pouring pad. Pad shall be doweled to existing concrete with #4 reinforcing rods located 3" inside pad perimeter on 12" centers.

D. Anchor bolts and sleeves shall be furnished for equipment provided under this Division to suit the equipment.

3.8 GROUTING

A. All mechanical equipment and pipe supports sitting on concrete shall be properly shimmed with stainless steel metal shims and grouted.

B. Grout shall be placed to completely fill the area between the equipment and the concrete.

C. Hollow equipment frames shall be completely filled with grout if recommended by the equipment manufacturer.

3.9 CUTTING AND PATCHING

A. All required openings shall be cut by the Contractor.

B. Under no circumstances shall any structural members, loadbearing walls or footings be cut without first obtaining written permission from the Engineer and Owner's Representative.

C. Cutting shall be in accordance with the following.

1. Concrete or Masonry: All openings for pipe in concrete or masonry materials shall be core drilled. Square or rectangular openings shall be saw cut, as necessary.

2. Grating and Floor Plate: Openings in grating and steel floor plate shall be neatly cut without irregular edges.

3. Roofing: All penetrations of roofing shall be made in strict accordance with manufacturer's recommended details so as not to void warranty.

D. Patching shall be in accordance with the following.

1. Concrete or Masonry: Install sleeves for piping penetrations in accordance with Section 232000. Patch the opening with grout finished smooth with adjacent surface.

2. Grating: All openings cut in grating shall be banded.

E. All below grade openings for pipe shall be sealed with interlocking synthetic rubber link assembly, Link-Seal by Thunderline Corporation or equal.

3.10 START-UP AND TESTS

A. The Contractor shall start-up the mechanical systems with his own personnel. Owner's personnel shall be in attendance.

B. The Contractor's performance of the start-up shall not constitute acceptance. The Work shall remain the responsibility of the Contractor until final acceptance.

C. Any equipment or system placed in temporary operation for testing or for the convenience of Contractor during construction and before Owner takes over operation shall be properly operated and maintained by Contractor.

D. All equipment and systems shall be protected against freezing, flooding, corrosion, or other form of damage prior to acceptance by the Owner.

E. Material or equipment damaged, shown to be defective, or not in accordance with the Specifications, shall be repaired or replaced to the satisfaction of Owner's Representative.

F. Before starting up any system, each piece of equipment comprising a part of the system, shall be checked for proper lubrication, drive rotation, belt tension, continuity of controls, and any other condition which may cause damage to equipment or endanger personnel.

G. Contractor shall provide a competent service representative trained in starting up and servicing the respective equipment for which he is responsible. Service representative shall be present to supervise the start-up of equipment and/or systems and training the Owner's personnel.

H. Test runs shall be made over the full design load range where possible or simulated to the satisfaction of Owner's Representative for other conditions. Tests shall continue for as long as necessary to demonstrate that systems will operate as designed.

I. During start-up, all necessary adjustments shall be made, controls checked for proper operation, motors checked for possible overload, and the entire system checked by Contractor for any abnormal condition.

J. During the start-up and prior to acceptance of any system, Owner's designated operating personnel shall be instructed in the operation and maintenance of the system.

K. After start-up has been concluded and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipe line strainers and filters shall be cleaned, air filters cleaned or replaced, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required. Temporary piping, ducting, wiring, instrument connections, etc., shall be removed, and openings restored in a permanent manner acceptable to Owner's Representative.

L. All tests shall be made after notification to and in the presence of the Owner's Representative and the authorities having jurisdiction.

END OF SECTION 230501

SECTION 230501 - GENERAL MECHANICAL REQUIREMENTS FOR HVAC –

ATTACHMENT 1 - ASCE Design Hazards Report – Moberly Correctional Center

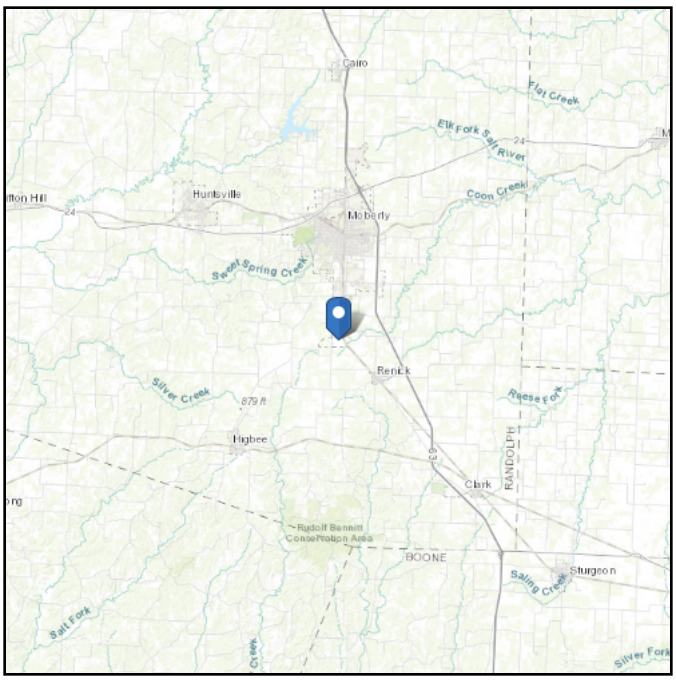
ASCE Hazards Report

Address:
Moberly Correctional Center - 5201 S Morley St
Moberly,

Standard: ASCE/SEI 7-22
Risk Category: IV
Soil Class: D - Stiff Soil

Latitude: 39.362414
Longitude: -92.440482
Elevation: 880.3095060471999 ft (NAVD 88)





Wind

Results:

Wind Speed	120 Vmph
10-year MRI	75 Vmph
25-year MRI	82 Vmph
50-year MRI	88 Vmph
100-year MRI	93 Vmph
300-year MRI	102 Vmph
700-year MRI	109 Vmph
1,700-year MRI	116 Vmph
3,000-year MRI	120 Vmph
10,000-year MRI	130 Vmph
100,000-year MRI	149 Vmph
1,000,000-year MRI	169 Vmph

Data Source: ASCE/SEI 7-22, Fig. 26.5-1D and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed: Tue May 20 2025

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-22 Standard. Wind speeds correspond to approximately a 1.6% probability of exceedance in 50 years (annual exceedance probability = 0.00033, MRI = 3,000 years). Values for 10-year MRI, 25-year MRI, 50-year MRI and 100-year MRI are Service Level wind speeds, all other wind speeds are Ultimate wind speeds.

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-22 Section 26.2.

Seismic

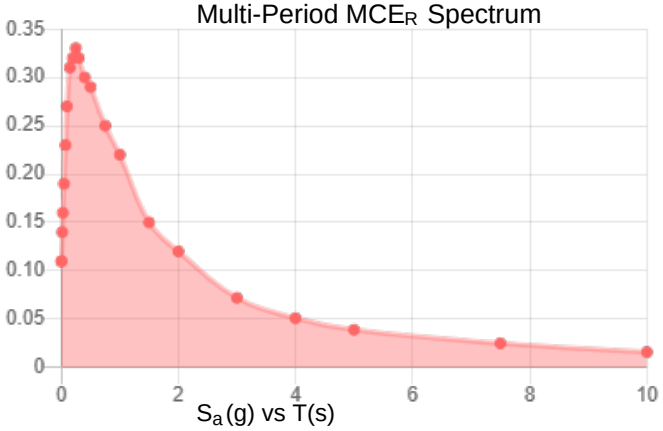
Site Soil Class: D - Stiff Soil

Results:

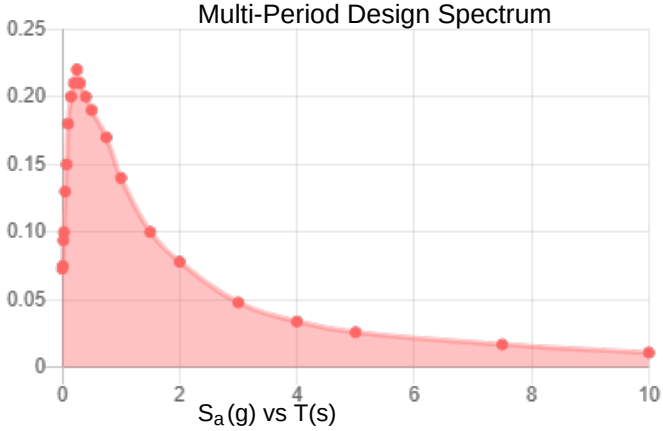
PGA_M :	0.1	T_L :	12
S_{MS} :	0.3	S_S :	0.23
S_{M1} :	0.22	S_1 :	0.1
S_{DS} :	0.2	V_{S30} :	260
S_{D1} :	0.14		

Seismic Design Category: D

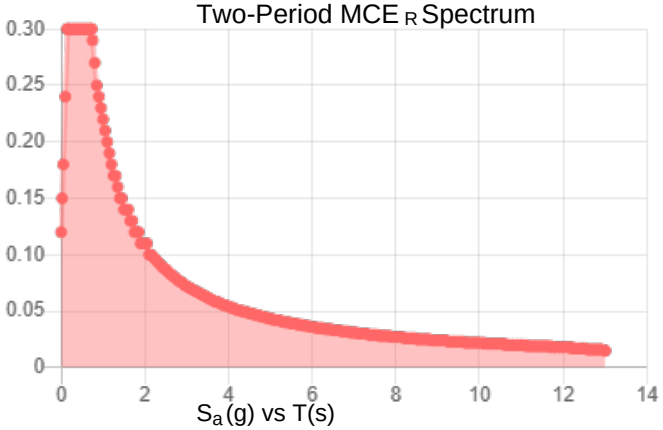
Multi-Period MCE_R Spectrum



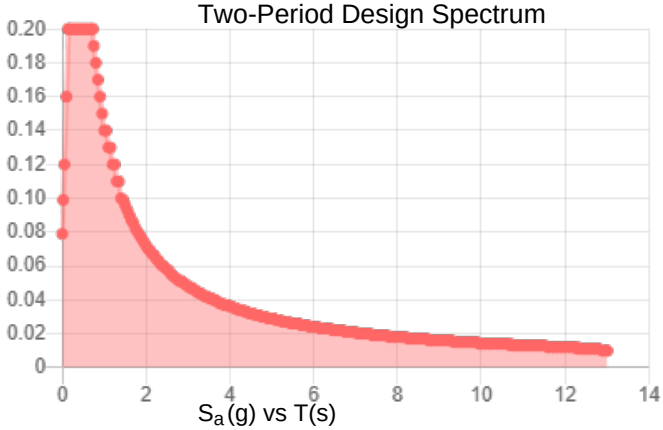
Multi-Period Design Spectrum



Two-Period MCE_R Spectrum



Two-Period Design Spectrum



MCE_R Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Data Accessed: Tue May 20 2025

Date Source:
USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.

Ice

Results:

Ice Thickness:	2.00 in.
Concurrent Temperature:	5 F
3-s Gust Speed	45 mph
Data Source:	Standard ASCE/SEI 7-22, Figs. 10-2 through 10-8
Date Accessed:	Tue May 20 2025

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain for 250, 500, 1,000, and 1,400-year mean recurrence intervals along with concurrent 3-s gust speeds and concurrent air temperatures. The shading indicates special icing regions, with elevations above 2,100 ft (640 m) in the east, 6,000 ft (1829 m) in the west, and 1,600 ft (488 m) in Alaska, with sparse weather station data for determining design ice loads. In these regions, as well as in regions with complex terrain causing unusual icing conditions and regions where snow or in-cloud icing results in larger loads, the mapped values should be adjusted based on a combination of local historical records and experience, reanalysis data, and numerical weather prediction systems.

Snow

Results:

Ground Snow Load, p_g :	38 lb/ft^2
20-year MRI Value:	11.13 lb/ft^2
Winter Wind Parameter:	0.55
Mapped Elevation:	869.8 ft
Data Source:	ASCE/SEI 7-22, Figures 7.6-1 and 7.6-2 A-D
Date Accessed:	Tue May 20 2025

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported ‘elevation’ and ‘mapped elevation’ differ significantly from each other.

Ground Snow Loads for IRC only, $p_{g(asd)}$:	26.6 lb/ft^2

Rain

Results:

15-minute Precipitation Intensity:	8.21 in./h
60-minute Precipitation Intensity:	4.45 in./h

Data Source: NOAA National Weather Service, Precipitation Frequency Data Server, Atlas 14(https://www.nws.noaa.gov/oh/hdsc/)

Date Accessed: Tue May 20 2025

The ASCE Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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SECTION 230505 – SELECTIVE DEMOLITION FOR HVAC

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 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment, and services necessary to perform all demolition work.

B. Work included in this Section includes all demolition work as shown on the Drawings and as specified herein and as required to complete the Work.

1.3 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity and interruption of utility services.

B. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finished surfaces, which might be misconstrued as damage caused by selective demolition operations.

C. Disposal Records: If hazardous wastes are removed by contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments

1.4 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

D. Prior to beginning demolition, arrange a conference with the Owner's Representative to review demolition scope, procedures, schedule, and items to be salvaged for the Owner.

1. The Owner retains the right of first refusal on all items shown to be removed by the Contractor.

1.5 PROJECT CONDITIONS

A. Owner will occupy site and buildings immediately adjacent to selective demolition areas. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Owner's Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection and life safety facilities in service during selective demolition operations.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.7 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative and Engineer.

E. Engage a professional engineer to survey conditions of existing structures to determine whether excavations or the removal of any element might result in structural deficiency or unplanned collapse of any portion of existing structures during selective demolition operations.

F. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No demolition work shall be performed without prior approval of the Owner's Representative.

B. Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

C. Any demolition work which interferes with Owner's operation shall be scheduled with the Owner's Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

F. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Owner's Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during demolition operations.

B. Comply with the International Fire Code including the requirements for fire safety during demolition and construction and for welding and other hot work.

1. Maintain a hot work program permit system, including fire watch.
2. Maintain portable fire-suppression devices in work areas.
3. Minimize hot work within occupied buildings.

C. Provide dust control and ventilation as required in areas of demolition.

D. Execute demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of demolition.

E. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the demolition work.

F. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

G. Protect existing surfaces, active utility services, and equipment which are to remain in place.

H. No blasting will be permitted.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.

B. Adequacy of the dust control methods shall be subject to the approval of the Owner's Representative.

C. Areas of major demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the demolition work unless otherwise directed by the Owner's Representative.

3.6 DEMOLITION - GENERAL

A. Remove all work indicated on the drawings and as required to complete the new work indicated.

B. During demolition operations, keep areas adjacent to demolition work free of dust and debris.

C. During demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Owner’s Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices in the area during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

C. Sidewalks, curbs, gutters, and pavement shall be neatly saw cut at existing joints where removal is required for new construction.

3.8 PIPING DEMOLITION

A. The Contractor shall use caution in the demolition of piping and shall inform himself of the conditions (fluid, pressure, temperature) of all piping systems to be demolished before making any cuts or breaking any joints.

B. Prior to breaking or cutting piping or tubing within the demolition area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be removed under this contract. Contact Owner's Representative for clarification prior to demolishing or removing questionable items.

C. Arrange for shutoff, isolation, and lock-out of piping with Owner's Representative or utility companies.

D. When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems.

E. All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged, or blind flanged.

3.9 ELECTRICAL DEMOLITION

A. See Section 260505 – Selective Demolition for Electrical in these Specifications.

3.10 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from demolition shall be properly sealed with material similar to the adjacent surface/finish.

B. All rough edges of openings created by demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

3.11 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area as directed by Owner's Representative.

E. Protect items from damage during transport and storage.

3.12 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.13 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

B. When permitted by Owner's Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.14 DISPOSAL

A. All debris resulting from demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Owner's Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not be permitted.

D. Transport demolished materials off Owner's property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.15 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations.

B. Return adjacent areas to condition existing before selective demolition operations began.

3.16 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, has identified hazardous materials such as friable asbestos in the work areas for removal on this project.

B. Inspect all instruments, controls, and lights to be removed for mercury. Dispose of mercury containing materials in accordance with applicable standards.

C. Should the Contractor discover additional material in the work area which is suspected to contain hazardous materials, do not disturb.

D. Contact and consult with the Owner's Representative prior to proceeding. The Owner's Representative shall direct the Contractor how to proceed.

END OF SECTION 230505

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 (latest edition) unless otherwise indicated.

B. Comply with IEEE 841 (latest edition) for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor

B. Efficiency: NEMA Premium Efficient, as defined in NEMA MG 1

C. Service Factor: 1.15

D. Multispeed Motors: Variable torque

1. For motors with 2:1 speed ratio: Consequent pole, single winding

2. For motors with other than 2:1 speed ratio: Separate winding for each speed

E. Multispeed Motors: Separate winding for each speed

F. Rotor: Random-wound, squirrel cage

G. Bearings: Regreasable, shielded, antifriction ball or roller bearings suitable for radial and thrust loading. Minimum AFBMA L10.

H. Temperature Rise: Match insulation rating

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T unless otherwise indicated in specifications.

L. Voltage and Speed: As indicated in the equipment schedule on the Drawings

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with vacuum pressure impregnated or inverter grade insulation system that meets the requirements of Section I, Part 31 “Definite-Purpose Inverter-Fed Polyphase Motors” of NEMA MG 1 designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

5. Grounding Ring: Provide AEGIS SGR shaft grounding ring for protection of the motor bearings from electrical discharge machining caused by capacitive induced shaft voltage discharging through the motor bearings. AEGIS SGR shaft grounding ring shall have 6061 aluminum frame with high conductivity micro

fibers and 6061 aluminum mounting bracket. The grounding ring shall be factory mounted on the motor shaft external to the motor housing.

C. Motors operated at frequencies greater than name plate rating: For direct drive equipment with top speed listed higher than nominal motor speed, motor shall be capable to operate at scheduled frequency on a continuous basis.

D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor
2. Split phase
3. Capacitor start, inductor run
4. Capacitor start, capacitor run

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading

D. Motors 1/20 HP and Smaller: Shaded-pole type

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

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 SCOPE

A. The Contractor shall furnish and install all manual valves as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Submit manufacturer's data sheet for each type valve. Data sheets shall be marked with the valve code noted herein (BA-1, etc.) for purposes of identification.

PART 2 - PRODUCTS

2.1 GENERAL

A. All valves shall comply with ASME 16.5, ASME B16.10, ASME 16.25, ASME B16.34, MSS-SP-45, MSS-SP-61, MSS-SP-84.

B. Valves shall provide shutoff per MSS-SP61 over a range of differential pressures up to the maximum pressure rating coincident with the operating temperature over a range up to the maximum temperature rating of the valves.

C. All valve stems shall be blowout proof.

D. Provide to Owner's Representative two operating wrenches for each type valve not equipped with handwheels or levers.

E. Provide suitable manual actuator for valves with unacceptably high operating torque due to service, size and style of valves.

F. All valves located 7' or more above floor, walkways or platforms, etc., shall be furnished with manufacturer's standard chainwheel operators, with chains extending to 5' above the operating level.

G. All valves shall have suitable devices for accepting padlock for locking the valve closed or open. When available, the valve manufacturer's standard locking arrangement shall be utilized.

H. Provide spare lubricant stick with each lubricated plug valve. Lubricant to be compatible with service requirements.

I. Packing shall be suitable for the intended service.

J. All valves 6” and larger on steam service shall have a two valve bypass around the valve installed in accordance with the drawings.

K. Bore on butt weld valves shall match mating pipe.

L. Ship valves completely assembled with end covers.

M. All materials contacting potable water shall be lead free.
1. Plumbing fittings and fixtures not in compliance with standards established in accordance with 42 U.S.C. 300g-6(e) (latest version) shall not be used.
2. When used with respect to solder and flux, refers to solders and flux containing not more than 0.2 percent (0.2%) lead.
3. When used with respect to pipes, pipes fittings, plumbing fittings, and fixtures, refers to pipes, pipe fittings, plumbing fittings, and fixtures containing not more than a weighted average of .25 percent (0.25%) lead.

2.2 MANUFACTURERS

A. Valve manufacturer is listed for purposes of clarification. Equivalent valves produced by an approved manufacturer may be used.

2.3 VALVES

A. Gate Valves – Flanged and Butt Welded:

TYPE	SIZE	ANSI PRESSURE CLASS	DESCRIPTION	MANUFACTURER'S NUMBER
GA-10	2-1/2" and over	150	Flanged Cast Steel OS&Y Flexible Wedge Stellite Trim Graphite Packing Welded Seat Rings	Crane No. 47XU-F Powell Fig 1503

B. Check Valves – Threaded:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
CK-2	2” and under	800S	Screwed Forged Steel Bolted Bonnet Conventional Port Swing Check 316 HF Hard Face Seat 13% Chrome Disc Horizontal/Vertical Up Flow Type	Vogt S701

C. Ball Valves – Threaded:

TYPE	SIZE	PRESSURE PSIG	DESCRIPTION	MANUFACTURER'S NUMBER
BA-1	2" and under	150 SWP 600 WOG	Screwed Bronze Body, 2 Piece Stainless Steel Trim Stainless Steel Handle TFE Seats and Seals	Apollo 70-100 Jamesbury A1100 Watts B-6000 NIBCO T-580
BA-2	2" and under	250	Screwed Bronze Body Bronze Trim Two Piece Full Port: ¼" to 1" Conventional Port: 1¼" to 2" Reinforced PTFE Seats and Seals PTFE packing MSS-SP-10 ANSI B16.33 Certified No. 2 Fuel Oil Service UL Listed for UL 842 for Flammable Liquid Shutoff	Apollo 77G-UL Apollo 80-100-UL Morrison 691 Nibco T-585-70-UL

PART 3 - EXECUTION

3.1 INSTALLATION

A. If space permits, install valves with stems extending vertically upward or within 60° of vertical unless specifically shown otherwise.

B. All valves shall be installed in accessible locations for operation as well as for removal, repair or replacement.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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 SCOPE

A. The Contractor shall furnish and install all pipe hangers and supports required for the HVAC piping and equipment systems.

1.3 SUBMITTALS

A. Product data sheets for expansion bolts, adhesive anchors, dielectric materials, and spring hangers.

B. Shop drawings for pipe support structural steel.

PART 2 - PRODUCTS

2.1 PIPE SUPPORT COATINGS

A. All pipe support materials located outdoors shall be galvanized.

B. All pipe support materials located indoors shall be painted in accordance with Division 9.

2.2 MANUFACTURERS

A. Manufacturer's figure numbers indicated herein or shown on the Drawings are Anvil and are for clarification purposes.

B. Equivalent material by Basic Engineers, Inc. or Bergen-Paterson may be used.

2.3 HANGER RODS

A. Hanger rods shall be electro-galvanized machine threaded rods (Fig. 140, 253) ASTM A36 or ASTM A575 with threads conforming to ANSI B1.1.

B. Minimum rod size shall be as follows

Pipe Size	Hanger Rod Diameter
2” and under	3/8”
2-1/2”, 3”	1/2”
4”	5/8”
6”	3/4”
8” thru 12”	7/8”
14” thru 18”	1”
20” thru 24”	1-1/4”

2.4 SADDLES AND SHIELDS

A. Hot, insulated, horizontal piping shall have pipe covering protection saddles (Fig. 160-166A) at all support points.

B. Saddle depth shall be equal to or slightly greater than insulation thickness.

C. Cold, insulated, horizontal piping shall have galvanized insulation protection shields (Fig. 167) at all support points.

2.5 HANGERS

A. Unless otherwise shown or specified, hangers for horizontal piping shall be as follows:

1. Uninsulated pipe: Adjustable clevis, (Fig. 260).
2. Insulated Pipe – Hot (200°F or less): Adjustable clevis, (Fig.260).
3. Insulated Pipe - Hot (212°F and above):
   a. 2-1/2" and under: Adjustable clevis, (Fig. 260)
   b. 3" and above: Adjustable steel yoke pipe roll, (Fig. 181)
4. Insulated Pipe - Cold: Adjustable clevis, (Fig. 260)
5. Copper Pipe: Adjustable tubing ring, plastic coated (Fig. CT-99C)
6. Plate Lugs: Forged steel clevis, (Anvil Fig. 299 or equal)

B. Unless otherwise shown or specified hangers for vertical piping shall be riser clamps (Fig. 261) installed below hubs, or lugs welded to the pipe or clevis with a plate lug welded to elbow at top of riser.

2.6 UPPER ATTACHMENTS

A. Unless otherwise shown or specified upper attachments shall be as follows:

1. 2" and under (optional): C-clamp with locknut (Fig. 86)
2. 4" and under: Malleable beam clamp with extension piece (Fig. 229) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).
3. 8" and above: Beam clamp with weldless eye nut (Fig. 292) or welded beam attachment (Fig. 66) with bolt and weldless eye nut (Fig. 290).

B. Unless otherwise shown or specified upper attachments for structural concrete ceilings shall be as follows:

1. Concrete single lug plate (Anvil Fig. 47 or equal) or clevis plate (Anvil Fig. 49 or equal). Expansion anchors shall be stainless steel.
2. For pipe 3" and under (optional): Carbon steel, drop-in type female expansion anchor.

C. Provide medium welded steel brackets (Fig. 195) for small bore pipe (2" or less) supported from concrete or masonry walls, if shown on Drawings.

D. Piping 2-1/2" and smaller may be supported eccentrically (9" maximum) with 3 x 3 x 1/4" angles welded to columns or beams which are at least 8" deep.

E. Not more than one eccentric attachment per beam will be permitted.

2.7 COPPER PIPE

A. Unless shown otherwise in the Drawings, copper piping shall be supported as follows:

1. Copper finished extension split tubing clamp (Anvil Fig. CT-138R or approved equal).
2. Copper plated adjustable clevis (Anvil Fig. CT-65 or approved equal).

B. Copper pipe shall be isolated from steel pipe support members with minimum 1/8" thick rubber sheet.

2.8 U-BOLTS

A. U-bolts for steel pipe shall be carbon steel furnished with four hex nuts and two jam nuts. (Anvil Fig. 137 or approved equal).

B. U-bolts for copper pipe shall be plastic coated carbon steel with hex nuts. (Anvil Fig. 137C or approved equal).

2.9 TUBE SUPPORT

A. Tubing for instrumentation and controls shall be supported with James C. White Company, Inc., "Tubetrack" or equal.

2.10 PIPE STANCHIONS

A. Pipe stanchions shall be Fig. 63 or field fabricated equal from Schedule 40 pipe and 3/8" thick base plate.

B. Stanchion size shall be half the size of the pipe being supported but not less than 2" diameter.

C. Stanchion base plate shall not sit directly on floor but shall have minimum 1" non-metallic, non-shrink grout underneath.

D. Bolt base plate to floor with stainless steel expansion anchors.

2.11 PIPE SUPPORT STRUCTURAL STEEL

A. Wide flange beams shall be ASTM A992 (50 ksi minimum yield stress).

B. Miscellaneous structural steel, plates, etc. for pipe supports and anchors in trenches and manholes shall be ASTM A36 (36 ksi minimum yield stress) of sizes and shapes as shown on the Drawings.

C. Structural tubing shall be ASTM A500, Grade B (46 ksi minimum yield stress).

D. Welding of structural steel supports and anchors shall be completed with E70XX electrodes.

E. All outdoor structural steel shall be hot-dipped-galvanized in accordance with ASTM A123, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2.12 EXPANSION BOLTS

A. Expansion bolts and nuts used in connection with pipe support structures shall be stainless steel, Hilti "KWIK BOLT TZ2" or approved equal by Powers or Red Head, installed per manufacturer's recommendations. Embedment shall be as follows, unless noted otherwise:

Bolt Diameter, in.	Embedment, in.
½	4
5/8	4
3/4	6
1	6

2.13 ADHESIVE ANCHORS

A. Anchors for fastening to concrete shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge and 304SS anchor bolts with washer and nut, Hilti HIT HY200 with HIT-Z-R anchor bolt with minimum 6" embedment, or approved equal by Powers or Red Head.

B. Anchors for fastening to masonry shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge, 304SS screen tube (for hollow construction) and 304SS thread rod with washer and nut, Hilti HIT HY20 or approved equal by Powers or Red Head.

C. Pipe supports from masonry shall be installed only after review and approval by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All piping shall be supported by suitable hangers to prevent excessive stress, swaying, sagging, or vibration.

B. Piping shall not be so restrained, however, as to cause it to snake or buckle between supports or anchors or to prevent movement due to expansion and contraction.

C. Hangers and supports shall be complete, including lock nuts, clamps, rods, bolts, couplings, swivels, inserts, required accessory items and secondary structural steel members.

D. Pipes shall be supported individually unless shown otherwise on drawings.

E. Provide supports, where pipe changes direction and at equipment connections.

F. Provide at least one hanger adjacent to each joint with mechanical couplings.

G. Weld pipe saddles to pipe.

3.2 SPACING

A. Unless otherwise shown on the Drawings the maximum spacing of supports for horizontal piping shall be as follows:

	Maximum Spacing, ft.	
Steel Pipe:	Steam, Liquids	Air & Gases
1/2”	5	6
3/4”	6	8
1”	7	9
1-1/4”	8	10
1-1/2”	9	11
2”	10	13
2-1/2”	11	14
3”	12	15
4”	14	17
6”	17	21
8”	19	24
10”	21	27
12”	23	30
16”	27	
18”	34	
24”	40	
Copper tubing:		
1” and under	5	
1-1/4”, 1-1/2”	7	
2” and above	10	
Cast Iron Pipe:		
6” and under	5 but not less than one support per pipe length	

B. Vertical pipe runs shall be supported and laterally braced at every floor level in multi-story structures and laterally braced only, at intervals not exceeding 15’ (10’ for 3” pipe and under) in other structures.

3.3 EXPANSION & ADHESIVE ANCHOR

A. Install in accordance with manufacturer’s instructions.

3.4 SEISMIC BRACING

A. Provide seismic (lateral) bracing for all piping with hanger length greater than 12” from the top of the pipe to the bottom of the support for the hanger.

B. Contractor shall field locate bracing. Bracing shall be installed in such location and manner so as not to restrict thermal movement for hot piping.

C. Unless otherwise shown, a pipe hanger used for lateral bracing shall include the following:

1. Clevis type hanger with pipe sleeve over horizontal through bolt.
2. 2 x 2 x 3/16 diagonal (1:1 slope) angle strut attached with bent clip angle to one side of hanger at through bolt. Weld or bolt other end of diagonal to support structure.

3. 2 x 2 x 3/16 angle to brace hanger rod for rods over 3' long. Weld angle to rod with 1/8" weld spaced 1" at 24" on center.

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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 SCOPE

A. The Contractor shall furnish and install identification labels for HVAC piping and equipment.

1.3 SUBMITTALS

A. Manufacturer's data sheet for identification labels.

B. Samples for identification labels.

C. Label Schedule, including a listing of all piping, duct, and equipment to be labeled with proposed content and coloring for each label.

PART 2 - PRODUCTS

2.1 GENERAL

A. Before ordering labels, Contractor shall review the proposed location for each label with the Owner's Representative and make any revisions to location or content as directed.

B. Contractor shall be responsible for obtaining all dimensions required to properly size and order labels.

2.2 LABELS

A. Label shall be heavy duty, self-adhesive, plastic type, rated for -40°F to 175°F surface temperature, which comply with ANSI/OSHA standards, Seton Opti-Code Self-Adhesive Pipe Labels or approved equal.

B. Label lettering shall be minimum 3”.

C. Label lettering shall be in accordance with manufacturer's recommendations.

D. Color coding shall comply with ANSI 13.1, latest.

E. Wording/color combinations shall be manufacturer's standard.

F. Direction of flow shall be included on each piping and duct label.

G. Piping Labels: Provide labels for the piping systems in accordance with Appendix A.

H. Duct Labels: Include identification of duct service using same designation or abbreviations as indicated on the drawings.

I. Equipment Labels: Include equipment's unique equipment number as indicated on the drawings.

1. Confirm equipment name and number with Owner's Representative prior to proceeding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply labels only after installation, painting, and insulating have been completed.

B. All surfaces shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of labels.

3.2 LABEL LOCATION

A. Review location of labels with Owner's Representative prior to installing.

B. Locate labels to be read easily from floor or platform levels.

C. Piping Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. Within 10' of connected equipment.
2. At intervals not exceeding 30' of pipe.
3. At branch points.
4. At every sectionalizing or main shutoff valve.
5. On each riser at a point 5' above floors and platforms.
6. Near points where pipes enter or leave concealed spaces.
7. At access doors, panels, or manholes which permit view into concealed spaces.
8. Where flow pattern is not obvious.

D. Duct Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. Within 10' of connected equipment.
2. At intervals not exceeding 30' of duct.
3. At branch points.
4. On each riser at a point 5' above floors and platforms.
5. Near points where ducts enter or leave concealed spaces.
6. At access doors, panels, or manholes which permit view into concealed spaces.

E. Equipment Labels: Locate labels as follows, unless indicated otherwise by Owner's Representative:

1. On equipment where accessible and visible.

PART 4 - APPENDIX "A"

4.1 PIPE IDENTIFICATION SCHEDULE

Piping System	Symbol	Label Legend
Chilled Water	CWS/CWR	Chilled Water Supply Chilled Water Return
Heating Water	HWS/HWR	Heating Water Supply Heating Water Return
Process Water	PW	Process Water
Natural Gas	NG	Natural Gas
Fuel Oil	FOS/FOR	Fuel Oil Supply Fuel Oil Return
Remote Radiator Coolant	GLYCSS/GLYCR	Coolant Supply Coolant Return
Engine Exhaust	EE	Engine Exhaust
Vent	V	Vent
Drain	D/CD	Drain

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Section Includes:

a. Testing, adjusting, and balancing of all air and hydronic systems included in the project work.

B. Related Sections include the following:

a. Section 230900 - Instrumentation And Control For HVAC

DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

A. Qualification Data: Submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Coordination Plan: For each system, list critical coordination activities to be completed with controls contractor and equipment service representatives.

E. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.

a. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.

b. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Engineer, Owner, Contractor, Control Subcontractor, and Commission Authority (if any) on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide 14 days' advance notice of scheduled meeting time and location.

a. Agenda Items:

b. The Contract Documents examination report.

c. The TAB plan.

d. Coordination and cooperation of trades and subcontractors.

e. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

b. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use approved TAB contractor's forms.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

A. Notice: Provide 7 days' advance notice for each test to Owner’s Representative and Engineer. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

C. Coordinate with controls contractor and equipment service representatives as required to provide fully functional HVAC systems.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers.

   a. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

   a. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

   b. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures.

Q. Observe and record system reactions to changes in conditions.

R. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

a. Permanent electrical-power wiring is complete.

b. Hydronic systems are filled, clean, and free of air.

c. Automatic temperature and flow control systems are operational.

d. Equipment and duct access doors are securely closed.

e. Balance, smoke, and fire dampers are open.

f. Isolating and balancing valves are open and control valves are operational.

g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

h. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's National Standards for Total System Balance, ASHRAE 111, NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, SMACNA's HVAC Systems - Testing, Adjusting, and Balancing and in this Section.

a. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

a. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

b. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is properly sealed.

L. Verify that fire and smoke dampers are properly installed.

a. Inspect existing fire and smoke dampers at the air-handling unit mechanical rooms.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS – DIESEL ENGINE REMOTE RADIATORS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

a. Measure fan speed.

b. Measure total airflow.

c. Measure fan static and total pressures.

d. Measure fan inlet and outlet temperatures.

e. Measure static pressure across each component that makes up the air system.

f. Set fans for maximum airflow and adjust radiator to deliver the maximum airflow.

1) Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed.
2) Comply with equipment manufacturer's requirements for adjustment of fans, belts, pulleys, and controllers to achieve indicated performance.
3) Do not make fan-speed adjustments that result in motor overload.
4) Consult equipment manufacturers about fan-speed safety factors.

g. Confirm fans operate in accordance with sequence of operation.

h. Measure fan-motor amperage across full engine operating range to ensure that no overload will occur.

i. Check fan for proper operation across full operating range without vibration, stalling, surging, overheating, etc.

3.6 PROCEDURES FOR VARIABLE-VOLUME AIR SYSTEMS - VENTILATION

A. Set intake and exhaust dampers at maximum open position which simulates full-ventilation load.

B. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan speed.
2. Measure total airflow.
3. Measure fan static pressures and total pressures.
4. Measure static pressure across each component that makes up the air system.
5. Set fan and dampers for maximum airflow and adjust controller to deliver the maximum airflow.
   a. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed.
   b. Comply with equipment manufacturer's requirements for adjustment of fans, belts, pulleys, and controllers to achieve indicated ventilation system performance.
   c. Do not make fan-speed adjustments that result in motor overload.
   d. Consult equipment manufacturers about fan-speed safety factors.
6. Confirm dampers and fans modulate in accordance with sequence of operation.
7. Measure fan-motor amperage across full operating range to ensure that no overload will occur.
8. Check fan for proper operation across full operating range without vibration, stalling, surging, overheating, etc.
9. Adjust fan minimum speed limit to optimize ventilation effectiveness.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

   a. Open all manual valves for maximum flow.

   b. Check liquid levels.

   c. Check glycol-water mixture ratios.

   d. Check flow-control valves for proper sequence of operation.

   e. Set system controls so automatic valves are wide open to heat exchangers.

   f. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

   g. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS – DIESEL ENGINE REMOTE RADIATORS

A. Measure engine cooling water flow, pressures, and temperatures through remote radiator across the full range of engine loads:

   a. Read pressure differential across the pump if possible.

      1) Convert pressure to head and correct for differences in gage heights.
      2) Note the point on manufacturer's pump curve and verify that the pump has the intended impeller size.

   b. Check system resistance with all valves open.

      1) Read pressure differential across the pump, if possible, and mark pump manufacturer's head-capacity curve.
      2) Read radiator and strainer inlet and outlet pressures and differential pressures.
      3) Read radiator inlet and outlet temperatures and differential temperatures.
      4) Read pump inlet and outlet temperatures and differential temperatures.
      5) Read engine coolant outlet temperatures.
      6) Read all available engine temperature gauges.
      7) Read indoor ambient temperatures at engine air intake.
      8) Read outdoor ambient temperatures at radiator air intake.
      9) Confirm engine coolant temperature control valve properly controls engine coolant temperature.

   c. Monitor engine performance during procedures and do not operate engines in overload conditions.

   d. Report engine coolant flow rates and temperatures which are not within plus or minus 10 percent of design.

B. Check settings and operation of all safety devices. Record settings.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

a. Manufacturer's name, model number, and serial number.

b. Motor horsepower rating.

c. Motor rpm.

d. Efficiency rating.

e. Nameplate and measured voltage, each phase.

f. Nameplate and measured amperage, each phase.

g. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum.

1. Test the manual bypass of the controller to prove proper operation, if provided.

2. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

a. Entering- and leaving-water temperature.

b. Enering- and leaving-water pressure.

c. Water flow rate.

d. Water pressure drop.

e. Dry-bulb temperature of entering and leaving air.

f. Wet-bulb temperature of entering and leaving air for cooling coils.

g. Airflow.

h. Air pressure drop.

i. Engine load.

3.11 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

a. Fans: Plus or minus 10 percent.

b. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to

facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

a. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

b. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

a. Pump curves.

b. Fan curves.

c. Manufacturers' test data.

d. Field test reports prepared by system and equipment installers.

e. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

a. Title page.

b. Name and address of the TAB contractor.

c. Project name.

d. Project location.

e. Engineer's name and address.

f. Contractor's name and address.

g. Report date.

h. Signature of TAB supervisor who certifies the report.

i. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

j. Summary of contents including the following:

k. Indicated versus final performance.

l. Notable characteristics of systems.

m. Description of system operation sequence if it varies from the Contract Documents.

n. Nomenclature sheets for each item of equipment.

o. Data for terminal units, including manufacturer's name, type, size, and fittings.

p. Notes to explain why certain final data in the body of reports vary from indicated values.

q. Test conditions for fans and pump performance forms including the following:

r. Settings for dampers.

s. Conditions of filters and strainers.

t. Cooling coil, wet- and dry-bulb conditions.

u. Damper settings.

v. Fan drive settings including settings and percentage of maximum pitch diameter.

w. Settings for variable-air-volume systems.

x. Settings for ventilation-air temperature controllers.

y. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

a. Airflow rates.

b. Water flow rates.

c. Duct, outlet, and inlet sizes.

d. Pipe and valve sizes and locations.

e. Terminal units.

f. Balancing stations.

g. Position of balancing devices.

h. Fire and smoke damper condition.

E. Fan Test Reports: For fan units with coils, include the following:

a. Unit Data:

b. Unit identification.

c. Location.

d. Make and type.

e. Model number and unit size.

f. Manufacturer's serial number.

g. Unit arrangement and class.

h. Discharge arrangement.

i. Sheave make, size in inches, and bore.

j. Center-to-center dimensions of sheave, and amount of adjustments in inches.

k. Number, make, and size of belts.

l. Number, type, and size of filters.

m. Motor Data:

n. Motor make, and frame type and size.

o. Horsepower and rpm.

p. Volts, phase, and hertz.

q. Full-load amperage and service factor.

r. Test Data (Indicated and Actual Values):

s. Total air flow rate in cfm.

t. Total system static pressure in inches wg.

u. Fan rpm.

v. Discharge static pressure in inches wg.

w. Coil static-pressure differentials in inches wg.

x. Outdoor airflow in cfm.

F. Apparatus-Coil Test Reports:

a. Coil Data:

b. System identification.

c. Location.

d. Coil type.

e. Number of rows.

f. Fin spacing in fins per inch o.c.

g. Make and model number.

h. Face area in sq. ft.

i. Tube size in NPS.

j. Tube and fin materials.

k. Circuiting arrangement.

l. Test Data (Indicated and Actual Values):

m. Air flow rate in cfm.

n. Average face velocity in fpm.

o. Air pressure drop in inches wg.

p. Outdoor-air, wet- and dry-bulb temperatures in deg F.

q. Entering-air, wet- and dry-bulb temperatures in deg F.

r. Leaving-air, wet- and dry-bulb temperatures in deg F.

s. Water flow rate in gpm.

t. Water pressure differential in feet of head or psig.

u. Entering-water temperature in deg F.

v. Leaving-water temperature in deg F.

G. Fan Test Reports:

a. Fan Data:

b. System identification.

c. Location.

d. Make and type.

e. Model number and size.

f. Manufacturer's serial number.

g. Arrangement and class.

h. Sheave make, size in inches, and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Motor Data:

k. Motor make, and frame type and size.

l. Horsepower and rpm.

m. Volts, phase, and hertz.

n. Full-load amperage and service factor.

o. Sheave make, size in inches, and bore.

p. Center-to-center dimensions of sheave, and amount of adjustments in inches.

q. Number, make, and size of belts.

r. Test Data (Indicated and Actual Values):

s. Total airflow rate in cfm.

t. Total system static pressure in inches wg.

u. Fan rpm.

v. Discharge static pressure in inches wg.

w. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

a. Report Data:

b. System and air-handling-unit number.

c. Location and zone.

d. Traverse air temperature in deg F.

e. Duct static pressure in inches wg.

f. Duct size in inches.

g. Duct area in sq. ft..

h. Indicated air flow rate in cfm.

i. Indicated velocity in fpm.

j. Actual air flow rate in cfm.

k. Actual average velocity in fpm

l. Barometric pressure in psig.

I. Cooling-Coil Reports:

a. Unit Data:

b. System and air-handling-unit identification.

c. Location and zone.

d. Room or riser served.

e. Coil make and size.

f. Flowmeter type.

g. Test Data (Indicated and Actual Values):

h. Air flow rate in cfm.

i. Entering-water temperature in deg F.

j. Leaving-water temperature in deg F.

k. Water pressure drop in feet of head or psig.

l. Entering-air temperature in deg F.

m. Leaving-air temperature in deg F.

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

a. Unit Data:

b. Unit identification.

c. Location.

d. Service.

e. Make and size.

f. Model number and serial number.

g. Water flow rate in gpm.

h. Water pressure differential in feet of head or psig.

i. Required net positive suction head in feet of head or psig.

j. Pump rpm.

k. Impeller diameter in inches.

l. Test Data (Indicated and Actual Values):

m. Static head in feet of head or psig.

n. Pump shutoff pressure in feet of head or psig.

o. Actual impeller size in inches.

p. Full-open flow rate in gpm.

q. Full-open pressure in feet of head or psig.

r. Final discharge pressure in feet of head or psig.

s. Final suction pressure in feet of head or psig.

t. Final total pressure in feet of head or psig.

u. Final water flow rate in gpm.

K. Instrument Calibration Reports:

a. Report Data:

b. Instrument type and make.

c. Serial number.

d. Application.

e. Dates of use.

f. Dates of calibration.

3.14 INSPECTIONS

A. Initial Inspection:

a. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

b. Check the following for each system:

c. Measure airflows.

d. Measure water flows.

e. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

f. Verify that balancing devices are marked with final balance position.

g. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

a. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer, Owner, Construction Manager, and Commissioning Authority (if any).

b. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer, Owner, Construction Manager, and Commissioning Authority.

c. Engineer shall select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in one normal 8-hour business day.

d. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

e. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

a. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

b. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 – HVAC 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 SCOPE

A. The Contractor shall furnish and install thermal insulation for piping, ductwork and mechanical equipment as shown on the Drawings and specified herein.

B. Reinsulate any existing piping, ductwork, or equipment that is to remain that had insulation removed as part of demolition work or to make tie-ins.

1. Unless noted otherwise, match existing insulation type, thickness, and finish.

C. Provide temporary insulation as required for personnel protection.

1.3 SUBMITTALS

A. Submit manufacturer's data sheet for each type of insulation to be used.

B. Submit manufacturer's data sheet for lagging to be used.

C. Submit material list clearly identifying insulation thickness, type, jacket, etc.

1.4 QUALITY CONTROL

A. Insulation systems shall be industrial grade installations in strict accordance with manufacturer's recommendations, the National Commercial and Industrial Insulation Standards (by Midwest Insulation Contractor's Association), and these specifications, whichever is more stringent.

PART 2 - PRODUCTS

2.1 GENERAL

A. Insulation and insulating materials containing asbestos shall not be used.

2.2 E-GLASS FIBER INSULATION FOR HOT PIPING (TYPE 1)

A. Insulation shall be rigid E-glass needle-mat fiber insulation, mandrel wound into a high density pipe insulation with inorganic binders and water resistant coating, with 12.5 lb/cf density, 28 psi compressive strength at 5% compression, 0.27% linear shrinkage at 1200 F, 1400 F maximum service temperature, 0.4 btu-in/hr/sf/F thermal conductivity at 400 F, less than 0.1% moisture absorption by volume, and 0/0 flame spread/smoke developed characteristics. Insulation shall be ESLIN Preformed Pipe Insulation, EG-SCUI Type, or approved equal.

B. Pipe Jackets: Insulation shall be covered with 0.020" thick, stucco embossed, stainless steel alloy jacket, ASTM A240, ASTM C1767, T-304, soft-annealed temper, with factory-applied baked-on acrylic or polyester exterior finish with 0.8 surface emittance (white), 3 mil polyethylene interior moisture barrier, ASTM E84 Flame Spread/Smoke Development Index of 25/50 or less.

2.3 REMOVABLE INSULATION COVERS

A. Existing indoor engine exhaust piping, silencer, and expansion joints shall be insulated with tight fitting, reusable insulation blankets suitable for diesel engine exhaust temperatures to 1200 F, including, but not limited to the following:

1. Inner layer of 309 stainless steel wire mesh cloth suitable for temperatures to 1800 F.
2. Insulation layer consisting of high density, ceramic fiber or CMS (calcium-magnesium-silica) fiber insulation suitable for operating temperatures to 1800°F.
3. Outer layer of high temperature aluminized fiberglass fabric suitable for operating temperatures to 1000 F.
4. Stainless steel lacing wire or spring clips connecting mushroom rivets or hook fasteners.
5. UL 2200 listing and label.
6. Insulation blanket shall provide a UL 2200 compliant, non-metallic, casual contact, safe touch surface temperature of 203°F or less with 1000 F exhaust temperature and 80 F ambient temperature and no wind.
   a. Minimum insulation thickness shall be 1”.
7. Insulation blankets shall be Firwin 1800 (design basis), Young Distribution Services, AB Thermal Technologies, or approve equal.

B. Flanged valves and strainers shall be insulated with tight fitting, reusable insulation blankets consisting of high density insulation (fiberglass or mineral wool) suitable for operating temperatures to 300°F, covered on outside with high temperature fabric having heavy adjustable straps with buckles/hooks/loops. Inside of blanket shall be covered with stainless steel square mesh woven wire cloth or fabric suitable to the specified temperature. Insulation thickness shall be sized for outer surface temperature of maximum 140°F, but shall be no less than 1” thick. Insulation blankets shall be Young Distribution Services, Firwin, AB Thermal Technologies, or approve equal.

C. Insulation blankets shall comply with UL 2200 requirements.

PART 3 - EXECUTION

3.1 STORAGE

A. All insulation and accessory materials shall be stored in an area that is dry and protected from the weather before and during insulation application.

3.2 INSTALLATION – INSULATION

A. Insulation shall be applied to pipe, fittings, flanges, valves, and muffler unless otherwise shown or called for.

B. Unions shall not be insulated.

C. All surfaces to be insulated shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of insulation.

D. All required tests on piping must be completed and satisfactory test reports must be submitted to the Owner's Representative prior to application of insulation covering joints.

E. Insulation shall be installed in a smooth, clean, workmanlike manner. Joints shall be tight and finished smooth. Cracked or chipped sections shall not be used in the work.

F. Insulation shall fit tightly against surface to which it is applied.

G. Sealant or cement shall not be applied until all previous applications of adhesives and cement have thoroughly dried.

H. Apply insulation in multiple layers and with expansion and contraction joints as required so as to permit expansion or contraction of pipe lines without causing damage to insulation, surface finish, or loss of insulating value.

I. Install insulation support lugs or rings on vertical pipe risers longer than 10 feet.

J. Preformed pipe covering shall be terminated at a sufficient distance from flanges to permit removal of bolts.

K. Insulation on flanges and flanged fittings shall overlap adjacent pipe covering at least 2".

L. Pipe insulation at expansion joints shall be held back a sufficient distance to permit the specified travel into the joint.

M. Valves shall be insulated up to the gland only so as to permit replacement of packing without disturbing insulation.

1. Glands shall be insulated with removable insulation covers.

N. Insulation shall be continuous through pipe covering protection saddles, guides and sleeves or openings in walls and floors.

O. Pipe line strainers shall be insulated in such a manner as to permit removal of strainer basket with minimal disturbance to insulation and vapor barrier on the strainer body.

P. Stagger longitudinal joints and tightly butt sections.

Q. Secure insulation with minimum 16 gauge galvanized wire on 9" centers.

R. Insulation with vapor barriers: Provide vapor-tight insulation systems with 100% complete vapor barrier.

1. Seal all longitudinal and circumferential joints vapor-tight with manufacturer's recommended contact adhesive.

2. Attach all ends of each insulation section to pipe, fittings, etc. with insulation adhesive to provide sectionalized vapor dams.

3. For valves, fittings, flanges, pumps, etc. fabricate sheet or tubing insulation into covers by butting and mitering joints as required. Seal all joints with contact adhesive.

4. Attach insulation at termination points (such as valve stems) with insulation adhesive and then the manufacturer's insulation mastic.

5. Apply insulation manufacturer's weather resistant finish to outdoor insulation.

6. Maintain vapor barrier integrity at interface with existing piping insulation.

3.3 INSTALLATION – DUCT WRAP

A. Install wrap per manufacturer's requirements.

3.4 INSTALLATION – JACKET

A. Lap joints downward to shed water.

B. Jacketing shall be lapped 2" and fastened with 1/2" wide stainless steel bands on 8" to 12" centers for piping. Provide band 1-1/2" back from all discontinuous ends of jacket.

C. Counter flash exposed ends of outdoor insulation.

D. Jacket shall not be run through pipe saddles and guides.

E. Comply with details if included on Drawings.

3.5 INSTALLATION – STANDARDS

A. Comply with insulation details included in the National Commercial and Industrial Insulation Standards (by Midwest Insulation Contractor's Association).

3.6 INSULATION THICKNESS

A. Insulation thickness shall be in accordance with Appendix A.

PART 4 - APPENDIX "A"

4.1 PIPE INSULATION SCHEDULE

Service	Symbol	Insulation Type	Pipe Size	Insulation Thickness
Engine Coolant	GLYCS/GLYCR	Type 1	2" and under 2-1/2" through 6”	1" 2.0"
Vents, Drains[A]	V, D	Note B	2” and under	1/2”

4.2 EXISTING EMERGENCY GENERATOR EXHAUST

Provide removable insulation blankets for existing indoor emergency generator exhaust in accordance with paragraph 2.4 Removable Insulation Covers:

Service	Symbol	Insulation Type	Size[C]	Insulation Thickness
Engine Exhaust Piping	EE	Removable	+/-14” OD x +/-20’	1” minimum
Engine Exhaust Expansion joint	EE	Removable	+/-14” OD x +/-2’	1” minimum
Engine Muffler	EE	Removable	+/-36” OD x +/-10’	1” minimum

Notes:
A. Insulate vent or drain valve and no less than 2’ of adjacent vent or drain pipe. Apply additional insulation as required for personnel protection on remainder of vent or drain pipe.
B. Match primary service pipe insulation type.
C. Sizes and lengths are approximate. Field verify existing conditions prior to proceeding.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

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 control equipment for HVAC systems and components.

1.3 SOLE SOURCE INSTRUMENTATION & CONTROLS SUBCONTRACTOR

A. The existing Building Automation System (BAS) at the Moberly Correctional Center Power Plant was installed in 2018 by C&C Group.

1. The installed BAS is founded upon a Schneider Electric StruxureWare platform.

B. The sole source Power Plant BAS subcontractor for this project shall be C&C Group. Contact:

1. Corey Schepers
2. C&C Group
3. cschepers@c-cgroup.com
4. (913) 530-7369

1.4 BAS INTEGRATION WITH PACKAGED EQUIPMENT CONTROL SYSTEMS

A. The existing Power Plant BAS shall interface with all new instrumentation and control systems, including instrumentation and control systems factory-packaged with new equipment.

1. Provide BAS operator interface screens which duplicate factory-packaged operator interface screens.
2. BAS shall monitor all available equipment system data, alarms, event history, etc. and provide critical equipment data collection, trending, and archiving.
3. Factory-packaged equipment system control from the BAS is not required unless noted otherwise, but shall be a capability for future implemenation.
4. Packaged equipment communication interface is typically specified elsewhere to be BACnet or Modbus TCP/IP protocol.
5. BAS system integrator shall coordinate with equipment manufacturer, field verify package equipment interface, and provide communication gateways as required.

1.5 GENERAL

A. Instrumentation and control systems shall be fully coordinated and integrated with associated equipment and systems.

B. Obtain all field information (dimensions, clearances, sizes, quantities, construction details, etc.) as required to properly complete the work.

C. Control system subcontractor shall complete site visits as required to coordinate control system design with existing conditions.

D. Submittals shall include control plans indicating the proposed location of all new controls.

1.6 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.7 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 5 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a. Space Temperature: Plus or minus 0.5 deg F.

1.8 SEQUENCE OF OPERATION

A. Refer to the drawings for Sequence of Operations.

1.9 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Control Plans: Control plan drawings indicating the location of all new controls.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:

a. Wiring diagrams for control units with termination numbers.

b. Schematic diagrams and floor plans for field sensors and control hardware.

c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Written description of sequence of operation including schematic diagram.

d. Points list.

D. Samples for Initial Selection: For each color required, of each type of wall-mount thermostat or sensor cover with factory-applied color finishes.

E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

F. Coordination Plan: For each control system, list critical coordination activities to be completed with testing, adjusting, and balancing contractor and equipment service representatives.

1.10 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For manufacturer, designer, programmer, and installer.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control, calibration, testing, and adjusting reports.

1.11 CLOSEOUT SUBMITTALS

A. As-built shop drawings, final system programming, and final system graphics.

B. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Data shall include, but not be limited to, the following:

1. Maintenance instructions and lists of spare parts for each type of control device.

2. Interconnection wiring diagrams with identified and numbered system components and devices.

3. Keyboard illustrations and step-by-step procedures indexed for each operator function.

4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

5. Calibration records and list of set points.

C. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.

2. Program Software Backup: On a compact disc, complete with data files.

a. Backup shall completely restore the system in the event of a computer malfunction.

b. Provide two complete sets of back-up disc(s).

3. Device address list.

4. Printout of software application and graphic screens.

5. Software license required by and installed for DDC workstations and control systems.

D. Warranty Certificates.

E. Extended Service Agreement

1.12 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish recommended spare parts and price list.

1.13 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.14 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from final completion and formal system acceptance by Owner’s Representative in writing.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner upon failure notification. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 24 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.15 EXTENDED SERVICE AGREEMENT

A. The controls contractor shall provide an extended service agreement for all control systems installed under this contract.

B. During the one-year warranty period, the controls contractor will be required to provide a complete inspection and calibration of the control systems installed under this contract 6 months and 12 months after final acceptance of the project.

1. Contractor will be required to repair or replace any defective components found during this inspection under the terms of the warranty.

2. The Contractor shall submit a written report describing the results of his inspection.

C. Beginning at the end of the one year warranty period and continuing for one year after this date, the Controls Contractor will be required to provide inspection and calibration of all controls installed under this contract 18 months and 24 months after final acceptance of the project.

1. All components found defective during this inspection shall be repaired or replaced at no additional cost to the Owner.

D. In addition to the regularly scheduled inspections, the Control Contractor, during the service agreement period, shall respond within 24 to non-emergency service requests and within 8 hours to emergency service requests by the Owner.

1. The Contractor shall repair or replace any components found defective and recalibrate all necessary system controls to insure proper system operation at no additional cost to the Owner.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at project completion.

1.17 COORDINATION

A. Coordinate location of exposed control sensors with plans, room details, and Owner's Representative before installation.

B. Coordinate with control systems included with equipment furnished by others.

C. Coordinate with fire-alarm systems to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate with panelboards and motor control centers to achieve compatibility with starter coils, motor starters, and annunciation devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:

1. Sole Source:

a. Schneider Electric/Invensys Building Systems through C&C Group.

b. Compatible with existing Power Plant Schneider Electric StruxureWare control system.

B. Control system shall consist of sensors, indicators, actuators, final control elements, operator interface equipment, communication systems, power supplies, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation, which permits interface with the network via dynamic color graphics for each mechanical system and control device depicted by point-and-click graphics, shall be provided.

2.3 DDC EQUIPMENT

A. Integrate new DDC equipment with existing power plant DDC system.

B. All new DDC equipment shall have a communications interface, which complies with ASHRAE Standard 135-2016, Bacnet™ -- A Data Communication Protocol For Building Automation And Control NETWORKS, to allow future integration with a new plant DDC system.

C. Operator Interface: Panel mount, touch screen interface, with minimum 7-inch diagonal, high resolution, wide-screen format, color LCD, provided with custom, application specific, real-time graphics and application software.

D. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
3. Standard Application Programs:
    a. Control units shall be fully custom programmable.
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

E. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

F. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

7. Universal I/Os: Provide software selectable binary or analog outputs.

G. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.

2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

H. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.

2. Maximum response time of 10 nanoseconds.

3. Minimum transverse-mode noise attenuation of 65 dB.

4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and **72**-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. Indoor Enclosure: Dustproof rated for operation at 32 to 120 deg F.

5. Outdoor Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.5 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.
2. Acknowledge Switch: Horn is silent and indicating light is steady.
3. Second Alarm: Horn sounds and indicating light is steady.
4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, pipe, or duct mounting as required.

B. Space Thermostat Sensor:

1. Accuracy: Plus or minus 0.5 deg F.
2. Integral Display: LCD display of space temperature and setpoint. Display shall indicate if display is actual temperature or setpoint.
3. Operator Input: Exposed setpoint adjustment buttons.
4. Communications: Capable of future connection to future building automation system, DDC, application specific controller, or device controller via digital data connection.
5. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Exposed.
    b. Temperature & Set-Point Indication: Exposed.
    c. Color: Provide color charts for Owner selection
    d. Orientation: Vertical, wall mount.

2.7 FLOW METER – ELECTROMAGNETIC TYPE (FE/FIT)

A. Flow meter shall be electromagnetic type which measures fluid flow using Faraday’s law of electromagnetic induction (i.e Induced voltage is directly proportional to the velocity of the conductive liquid.).

B. Meter shall have a uniform magnetic field flux distribution which eliminates the need for piping straight meter runs and flow profiling.

C. Meter shall be suited for measuring dynamic, non-continuous flow.

D. Meter shall operate with +/- 0.25% accuracy at a 300:1 turndown without flow profiling or a piping straight run exceeding 1.5 pipe diameters from meter centerline in all piping configurations.

E. Meter K-factor shall be stable and not influenced by external piping or mounting orientation.

F. Flow meter shall consist of a full-bore body with an encapsulated and rigidly retained set of coils and microprocessor based converter/transmitter as follows:

1. Flow Element Housing: Carbon steel, flanged, polyurethane resin coating.
2. Flanges: Forged, carbon steel, ASTM A105, raised face, weld neck, ANSI B16.5, Class 150.
3. Fluid Temperature Range: -4 F to 248 F.
4. Pressure Rating: Full Vacuum to 150 psig at 248 F.
5. Minimum Fluid Conductivity: 3 microsiemens per centimeter.
6. Flow Range: 0 to 33 feet per second.
7. Flow Accuracy: ± 0.25% of rate above 0.11 feet per second.
8. Lining:
   a. PFA (Teflon) with 250 F continuous duty temperature rating, unless noted otherwise.
9. Electrode: Hastelloy C22.
10. Grounding Ring: Hastelloy C.
11. Converter/Transmitter Mounting: Remote.
12. Converter/Transmitter Structure: Aluminum Alloy, IP 67, NEMA 4X watertight, baked acrylic resin coating.
13. Display: LCD.
14. Flow Signal Output: 4 to 20 mAdc and pulse.
15. Repeatability: ± 0.5% of rate.
16. Digital Outputs: Empty pipe alarm.
17. Communications: Hart protocol.
18. Power Supply: 100 to 240 Vac, 60 Hz, 20 watts maximum.
19. Ambient Temperature Range: -40 F to 140 F.
20. Vibration Resistance: 10 to 150 Hz with 9.8 meters per second2 acceleration.

G. Flow meter shall be hydrostatically tested.

H. Flow meter shall be factory calibrated in a NIST traceable flow test facility which is capable of ±0.25% calibration accuracy. Calibration tests shall be recorded, certified, and supplied with each meter. Calibration tests shall include, but not be limited to, the following:

1. Accuracy of flow indication at three (3) test points over a range of minimum to maximum flow.
2. Flow coefficients over an approximate Reynolds Number range corresponding to the minimum and maximum flows.
3. Calibration tests shall be performed on the actual meters provided.

I. Flow meter calculations and associated transmitter calibration and configuration shall be based on calibration test results.

J. Acceptable manufacturers, subject to compliance with specifications:

1. Cadillac® CMAG, or approved equal by Badger, Foxboro, Emerson.

2.8 ELECTRIC ACTUATORS - DAMPERS

A. Sized for damper break-away and operating torque requirements with sufficient reserve power to provide smooth action and proper speed of response at worst cast damper conditions.

1. Field verify torque requirements on existing dampers to remain in place.

B. Provide all mounting hardware and linkages.

C. Two-Position Actuators:

1. 120-volt, single phase, electric powered.
2. ISO 9001, cULus, CE, and CSA listed.
3. NEMA 4, UL Type 4 approved, IP 66 rated, aluminum housing with plastic junction box.
4. Brushless motor technology, with microprocessor control, protected for overload at all angles of rotation, 75 second run time (max.)
5. -22 to 122 F temperature range, 95% relative humidity, non-condensing.
6. Fail-safe operation, with continuously engaged mechanical spring return that returns to damper fail-safe position within 10 seconds of power loss at -4 F to 122 F and within 15 seconds at -22 F to -4 F.
    a. Fail Safe Position as scheduled on drawings.
7. Built-in limit end stop to match available damper rotation.
8. Manual override with locking function.
9. External position indicator.
10. Two Auxiliary End switches set at 10^{o} and 85^{o} for position indication and equipment interlocks, SPDT, 3A resistive maximum load at 250Vac.
11. Linkage – corrosion-resistant, provide members as required.
12. 5-year warranty.
13. Belimo EFCX or approved equal by control system manufacturers named above.

D. Modulating Actuators:

1. 24 VAC/DC, electric powered.
2. Proportional control in response to a 2 to 10 VDC control signal.
3. ISO 9001, cULus, CE, and CSA listed.
4. NEMA 4, UL Type 4 approved, IP 66 rated, aluminum housing with plastic junction box.
5. Brushless motor technology, with microprocessor control, internal feedback, protected for overload at all angles of rotation, 95 second run time (max.)
6. -22 to 122 F temperature range, 95% relative humidity, non-condensing.

7. Fail-safe operation, with continuously engaged mechanical spring return that returns to damper fail-safe position within 20 seconds of power loss at -4 F to 122 F and within 60 seconds at -22 F to -4 F.

   a. Fail Safe Position as scheduled on drawings.

8. Built-in limit end stop to match available damper rotation.

9. Manual override with locking function.

10. External position indicator.

11. Two Auxiliary End switches set at 10° and 85° for position indication and equipment interlocks, SPDT, 3A resistive maximum load at 250Vac.

12. Linkage – corrosion-resistant, provide members as required.

13. 2 to 10 VDC position feedback signal.

14. 5-year warranty.

15. Belimo EF Series or approved equal by control system manufacturers named above.

2.9 CONTROL CABLE

A. Conduit and Raceway:

1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.

2. Aluminum rigid conduit or Galvanized rigid steel conduit: Outdoors.

3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment,

4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

B. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color-coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multiconductor cable rated for use in cable trays per NEC articles 392 and/or 725.

C. Automation Input/Output Wiring: Wiring serving inputs and outputs from the automation system shall be cables consisting of single or multiple twisted pairs, an overall aluminum foil type shield with a 22 AWG stranded drain wire.

D. Cables installed without conduit shall be plenum rated and comply with NEC article 725.

E. All cable splices must be contained within a UL approved metal junction box.

F. Multi-conductor cable shall only be used where all the points are at a single location and for the same device (i.e., variable frequency drives, each individual motor starter). Single conductor cables shall be used for all temperature transmitters, pressure transmitters, flow meters, differential pressure switches, control valves and any other locations where the points are not grouped together at the same device. Where automation input/output

wiring is run in cable tray furnish and install conductors or multi- conductor cable rated for use in cable trays per NEC articles 392 and/or 725. Conductors shall be a minimum 18 AWG wire gauge. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.

G. Building Automation Network: Wiring serving communication trunks from the automation system shall be as required by the network protocol. Cables installed without conduit shall be plenum rated and comply with NEC article 725. Where wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 392 and/or 725.

2.10 AUXILIARY PANELS

A. Manufacturers

1. Hoffman
2. Hubbell-Wiegmann

B. Description

1. NEMA 12, Minimum 16ga steel bodies and 14ga steel doors sizes through 24" x 24", larger sizes all 14ga, seams continuously welded and ground smooth. Doors shall be hinged for 180° swing, oil resistant gasket, removable print pocket, door clamps with bolts, hasp and staple for padlocking. Collar studs shall be provided to mount a sub-panel. Finish shall be white inside and gray ANSI 61 outside over phosphatized surfaces. Subpanels shall be white polyester powder finish.

2.11 SPECIALTY TERMINAL BLOCKS

A. Manufacturers

1. Phoenix
2. Weidmuller
3. Entrelec
4. ABB

B. Description

1. Terminal blocks shall allow the entering conductor to be disconnected from the leaving conductor using sliding link, knife link or plug switch.
2. Terminals shall be rated for voltage and current of the circuit.
3. Terminals shall have test jacks and allow meter to be connected without interference of the disconnecting means.
4. Standard DIN EN50022 mounting rail mounting.

C. Components shall include, but not be limited to, the following:

1. Fuse holder terminal blocks: Provide with fuse station indicator.
2. Feed through terminal blocks.
3. Grounding type terminal blocks.

4. Resistor style terminal blocks.

5. Component holder terminal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units.

B. Verify new control instruments and devices are suitable for existing control system.

C. Verify that existing control systems, instruments, devices, etc., which are to remain, are operational.

1. Check calibration and function on existing instrument and devices. Recalibrate as required.

2. Submit calibration and test reports.

D. Advise Owner's Representative and Engineer of any issues with existing equipment or controls to remain in service.

3.2 INSTALLATION

A. Comply with manufacturers' instructions.

B. Install software in control units and operator interfaces.

C. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

D. Connect and configure equipment and software to achieve proper sequence of operation.

E. Verify location of room temperature sensors and other exposed control sensors with existing conditions and Construction Representative before installation. Install devices 60 inches above the floor.

F. Install guards on room sensors with setpoint adjustment capability.

G. Install damper motors on outside of duct or damper frame.

H. Install labels and nameplates to identify control components.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. General Requirements:

1. Bundle and harness multiconductor instrument cables in place of single cables where several cables follow a common path.

2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

3. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

4. Install wire and cable with sufficient slack and flexible connectors to allow for vibration of piping and equipment.

5. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.

B. Install motor interlock wiring and power wiring (for Division 230900 components) as indicated below:

1. All wiring shall be installed in raceway according to Section 260533.13 – Conduit for Electrical Systems.

C. Install building automation network and automation input and output wiring. Cables shall be installed in raceway as described below.

1. In mechanical spaces, cable shall be installed in raceway according to Section 260533.13 – Conduit for Electrical Systems.

2. Above suspended ceiling, open plenum rated wiring will be permitted. Cables shall be supported with J-hooks a minimum of every six feet. Bridal rings can be used when supporting a maximum of 6 wires. Support devices are to be attached to permanent structure.

3. At all other spaces not previously defined, cable shall be installed in raceway according to Section 260533.13 – Conduit for Electrical Systems.

D. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 POWER FOR CONTROL PANELS, EQUIPMENT AND SYSTEMS

A. Power for control panels, controllers, etc. shall be the responsibility of this section. Power shall be obtained from lighting panels, distribution panels or as indicated on drawings.

B. The section shall be responsible for bringing all power required by, but not limited to actuators, transmitters, etc. from a main control system auxiliary panel to the point of use. This includes furnishing and installing any branch circuit protection equipment and disconnecting equipment required to comply with code requirements.

C. The contractor shall extend existing equipment grounding system. The contractor shall use only approved grounding clamps and connectors as manufactured by Penn-Union, Burndy, or O-Z Manufacturing Company.

1. Install a green equipment grounding conductor inside all conduits. Bond all junction boxes, conduit, and equipment. Terminate equipment grounding conductor at electrical panel grounding bus.

3.5 AUXILIARY PANELS INSTALLATION AND FABRICATION

A. Auxiliary panels shall be fabricated to match the approved shop drawings submitted by the control contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.

B. All equipment that is not providing an input from a field sensed process (static pressure, temperature, proof of flow, etc.) shall be installed in an auxiliary panel located as indicated on the drawings or as directed by the engineer.

C. Auxiliary panels shall be fabricated and laid out to incorporate the following features:

1. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels. Labels for internal devices may be self-adhesive printed tape. Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label.

2. All input and output wiring entering the stand alone control units shall be terminated on sliding link or knife switch type disconnecting type terminal strips to allow the field wiring to be isolated from the stand-alone unit for trouble shooting and to allow current loops to be tested without lifting any of the wiring. If such terminal strips are not furnished as a standard part of the stand-alone control unit termination points, then they shall be installed in an auxiliary panel located immediately adjacent to the stand-alone unit.

3. All internal wiring shall be run inside plastic wiring duct as manufactured by Panduit. Wire duct shall be sized to hold the required number of wires without crimping the wires and with sufficient space to allow wiring to be traced during troubleshooting operation.

4. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge.

5. All control panels shall be provided with removable sub-panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off-site for later installation.

6. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.

7. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel's 120 VAC power source.

8. Provide one under cabinet type fluorescent light with switch mounted internally in the control panel.

9. Each panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.

10. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level ac and dc signals cross wires containing power and high-level ac signals, the wires shall cross at a 90° angle.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

    a. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.

5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

6. Test each system for compliance with sequence of operation.

7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check installation of wiring for each instrument.

5. Check temperature instruments and material and length of sensing elements.

6. Check electric-operated dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.

7. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.

    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.

    c. Verify that spare I/O capacity has been provided.

    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.7 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:

   a. Check analog inputs at 0, 50, and 100 percent of span.

   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

   c. Check digital inputs using jumper wire.

   d. Check digital outputs using ohmmeter to test for contact making or breaking.

   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Temperature:

   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

   b. Calibrate temperature switches to make or break contacts.

6. Stroke and adjust control dampers without positioners, following the manufacturer's recommended procedure, so that damper is 100 percent open and closed.

7. Stroke and adjust control dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

8. Provide diagnostic and test instruments for calibration and adjustment of system.

9. Provide written description of procedures and equipment for calibrating each type of instrument.

10. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Report results in writing.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

B. Provide a minimum of four (4) hours of instructions to Owner's personnel (6 to 12 people) in the operation and maintenance of the control system.

C. The training shall be scheduled with the Owner’s Representative to accommodate Owner's schedule but will be performed during normal business hours.

D. Provide training after the system has been installed and checked out.

END OF SECTION 230900

SECTION 231113.20 – FACILITY FUEL-OIL PIPING – SECONDARY CONTAIMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

A. Contractor shall furnish and install fuel oil piping systems with secondary containment as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Contractor shall submit the following.

B. Product data, shop drawings.

C. Piping layout drawing indicating piping arrangement and dimensions as well as locations of field welds, anchors, expansion fittings, cold-pull requirements, etc. Indicate dimensions of oversized conduit expansion fittings.

D. Typical details for conduit system, building entries, anchors, supports, gland seals, field joints, etc.

E. Manufacturer's stress and anchor force analysis for system.

F. Materials of construction including type, schedule, thickness, etc. for carrier pipe, conduit, insulation, and jacket.

G. Material test reports for carrier pipe.

H. Manufacturer’s assembly, installation, testing, and start-up instructions.

I. Control and electrical schematics, wiring diagrams, external power supply requirements, and panel layouts. Include clear indication of all field wiring required.

J. Product warranties.

K. Installer’s qualifications and experience.

L. Certification letter from manufacturer(s) that contractor(s) (or subcontractor(s)) doing work is an acceptable installer.

M. Factory test certificates.

N. Installation checklists and field test certificates for all systems and accessories.

O. Certification of inspection and proper installation from manufacturer(s).

P. Copies of all required warranty registration documents submitted to manufacturers.

Q. Operating and maintenance manuals.

R. Proof of compliance with Rules of Missouri Department of Agriculture's Petroleum Inspection Program, Division 90 – Weights, Measures and Consumer Protection, Chapter 30 – Petroleum Inspection, 2 CSR 90, including, but not limited to, the following.

1. Installer notifications.
2. Manufacturer's certification and training compliance.
3. Installer's DNR/Department of Agriculture registration.
4. Manufacturer's DNR/Department of Agriculture registration.
5. Installers proof of current financial responsibility.
6. Manufacturer's current financial responsibility.
7. Preinstallation inspection and testing results.
8. Post-installation inspection and testing results.
9. DNR inspection and approval reports.
10. Certification of Installation.

1.4 STANDARDS

A. Work shall be performed in accordance with all applicable federal, state and local building, fire protection, environmental, and safety codes and regulations, including, but not limited to, the latest version of the following.

B. International Building Code family, including, but not limited to, the International Building Code, International Fire Code, International Mechanical Code, International Plumbing Code.

C. Rules of the Missouri Department of Agriculture's Petroleum Inspection Program.

D. Petroleum Equipment Institute's RP200, Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling.

E. National Fire Protection Association's Flammable and Combustible Liquids Code, NFPA 30, Automotive and Marine Service Station Code, NFPA 30A, Standard for the Installation of Oil-Burning Equipment, NFPA 31, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, NFPA 37, National Electrical Code, NFPA 70, Standard for Emergency and Standby Power Systems, NFPA 110, and Underground Leakage of Flammable and Combustible Liquids, NFPA 329.

F. Occupational Safety and Health Standards, Flammable and Combustible Liquids, 29 CFR 1910.106, Personal Protective Equipment 29 CFR 1910 Subpart I, U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Washington, D. C.

G. American Society of Mechanical Engineers, ASME B31.1, Power Piping.

H. Where differences exist between standards, the Contractor shall use the most conservative.

1. If in doubt, describe differences in writing to the Engineer for approval before performing the work.

I. The codes and standards listed are the latest as of this publication.

1. Codes and standards are continuously updated.
2. The Contractor shall confirm the construction standard edition enforced by the authority having jurisdiction.

1.5 QUALITY ASSURANCE

A. Fuel oil piping system shall be furnished and installed as a packaged system which is designed, coordinated, and integrated by the suppliers, manufacturers, and installing contractors as required to provide a fully functional fuel oil piping system as shown on the Drawings and specified herein.

B. Installation contractor shall have been regularly engaged in the installation and maintenance of fuel storage and piping systems for a minimum of 10 years, shall have completed 10 similar projects, and shall be certified by manufacturer(s) and State of Missouri as an authorized installer.

C. Listings: Components of the system(s) for which Underwriters' Laboratories, Inc. (UL) provides product listing service, shall be listed and bear the listing mark.

D. Provide installation, inspection, testing, startup, and training of Owner's personnel for all systems.

E. Training of Owner's personnel shall be completed by each manufacturer's certified field engineer, at no additional cost to the Owner.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Above Piping System:

a. Warranty Period: Manufacturer's standard 12 month from date of completion of installation and testing or18 month from shipment.

1.7 MANUFACTURERS

A. Manufacturer's indicated herein or shown on the Drawings are specified to clarify the intent of the specifications. Equivalent products may be used subject to engineer's approval.

PART 2 - PRODUCTS

2.1 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS - GENERAL

A. Fuel oil piping system shall include a factory-engineered and fabricated, secondary containment piping system and associated fittings, transition assemblies, couplings, adaptors, seals, boots, entry fittings, test fittings, valves, accessories, etc. as required to contain all leakage and provide a fully functional, integrated fuel oil piping system.

B. Piping system shall include provisions for leak detection as specified below and shown on the drawings.

C. All components of the piping system shall be corrosion resistant and compatible with the service conditions.

1. All components shall be suitable for service with gasoline, alcohols, No. 2 fuel oil, and all EPA approved additives.

D. The fuel oil secondary containment piping system shall be a factory engineered, factory fabricated, airtight, conduit type system with steel carrier pipe, Class "A" drainable, dryable, and testable steel conduit, and fiberglass reinforced plastic jacket.

E. Conduit system shall be suitable for severe above ground environments and all ground water and soil conditions.

F. The conduit piping system and all components and accessories shall be provided by the same manufacturer. Acceptable manufacturers, subject to the Specifications, are:

1. Thermacor Process, Inc.
2. Perma-Pipe, Inc.
3. Rovanco Piping Systems.

G. Contractor shall make all field measurements required to accurately fabricate the conduit piping system.

H. Manufacturer of conduit piping system shall provide factory-trained field representative to train and assist Contractor’s personnel in critical field installation operations (i.e. unloading, field joint construction, testing, etc.).

I. Conduit piping system shall be prefabricated to the maximum extent possible.

1. Unless required otherwise, straight sections of conduit piping shall be factory furnished in minimum 40 foot lengths.

2.2 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS – DESIGN REQUIREMENTS

A. Design parameters for the prefabricated conduit pipe system shall be as follows:

1.	Service:	No. 2 Fuel oil
2.	Design Pressure:	200 psig
3.	Design Temperature:	-20 F to 150 F
4.	Location:	Outdoors, above ground, in concrete chase.

B. The assembled conduit system shall provide sufficient mechanical strength to resist loads from handling during construction and installed gravity loads.

C. Manufacturer shall design the system to allow for thermal expansion of the carrier pipe.

1. Stress from thermal expansion shall not exceed that allowed by the Power Piping Code, ANSI B31.1 (latest).

D. The piping system shall be designed and shop fabricated at the manufacturer's factory.

E. The size of all pipe is identified by the nominal pipe size. All references to wall thickness, schedule number, and weights are defined by ANSI B36.10. Variation in pipe dimensions and tolerances shall conform to ASTM specification for each pipe material specified herein.

2.3 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS – CARRIER PIPE

A. Carrier pipe shall be seamless carbon steel, ASTM A106 Grade B, Schedule 80, butt weld.

B. Material test reports shall be provided for all carrier pipes.

C. Fittings shall be extra heavy weight, butt weld carbon steel, ASTM A234, ANSI B16.9. Elbows shall be long radius.

D. Joints shall be butt welded.

E. Butt weld root pass (and second pass if required to prevent blow through) shall be by gas tungsten arc welding (GTAW).

F. All concealed carrier pipe welds in prefabricated conduit and fittings shall be tested for proper quality using nondestructive, testing procedures (ultrasonic or radiography) at the factory and the results interpreted by an independent testing company.

1. Testing shall be performed in accordance with Article 2 of Section V of the ASME Boiler and Pressure Vessel Code (latest edition) and interpreted in accordance with criteria set forth in ANSI B31.1.
2. Defective welds shall be repaired and the weld retested until it passes.

G. Carrier pipe shall be properly supported and guided within steel conduit, on no greater than 10 foot centers.

H. Supports shall allow thermal expansion and continuous drainage and airflow in the conduit space.

I. Supports shall occupy no greater than 10% of the annular air space.

2.4 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS – CONDUIT CASING

A. Conduit casing shall be seamless, or ERW, carbon steel, ASTM A139 Grade B, welded and pressure tested, galvanized, with fiberglass reinforced plastic jacket.

1. Schedule 40 for 5” or less diameter conduit.
2. 10 gauge for 6” or larger diameter conduit.

B. Conduit casing shall be hot dipped galvanized per ASTM A123 with minimum 2 ounces per square foot and minimum 3.4 mils thickness.

C. Conduit shall be sized to provide adequate air space between conduit and carrier pipe to provide fully drainable, dryable, and testable system. Air space shall be no less than 1 inch.

D. Fittings shall be factory fabricated.

E. Field joints shall be minimized and shall occur at straight sections of pipe only.

F. Field joint locations for above ground installations shall be coordinated with the conduit support locations shown on the drawings.

G. Pressure-testable conduit casing closures shall be provided for all field joints.

H. Conduit casing closures shall consist of the same materials as specified for the prefabricated conduit casing.

I. All materials and insulation required for complete field closure shall be furnished with the conduit.

2.5 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS – CONDUIT JACKET

A. Conduit shall be encased in a fiberglass reinforced plastic jacket with 100 mils minimum wall thickness and 35,000 volt dielectric strength.

B. Jacket shall be polyester fiberglass with UV inhibitor in accordance with ASTM D-2996.

C. Jacket shall be filament wound fiberglass on straight sections of conduit and spray-applied, chopped fiberglass mat on fittings.

D. Conduit surface preparation shall be as required to properly bond galvanized conduit with fiberglass jacket.

E. Fiberglass jacket closures shall be provided for all field joints.

F. All materials required for complete field closure shall be furnished with the conduit.

2.6 FUEL OIL PIPING – SECONDARY CONTAIMENT SYSTEMS – END SEALS

A. Terminal ends of conduits shall be sealed watertight, with gland seals consisting of steel closure plate, stainless steel bolts, gland with high temperature packing, and gland follower.

B. End seals shall include minimum 1/2" vent and drain connections with plugs

C. Extend steel conduit a minimum of 6" beyond face of walls, floors, etc.

D. Extend carrier pipe a minimum of 6" beyond end of steel conduit.

2.7 CORROSION PROTECTIVE TAPE SYSTEM

A. Provide corrosion protection tape system on exposed, uncoated, carbon steel carrier piping.

B. Corrosion protection tape system shall include a rubber based primer compatible with tape adhesive and minimum 10 mil polyvinyl chloride (PVC) tape with high-tack adhesive designed for corrosion protection of above ground and below ground piping systems across the full range of ambient temperatures.

C. Provide a compatible putty build-up compound for irregular surfaces as required to provide a suitable surface for taping.

D. Tape system shall be as follows, or approved equal:

1. Tape: 3M Scotchrap All-Weather Corrosion Tapes 50 or 51
2. Primer: 3M Scotchrap Pipe Primer
3. Putty: Scotchfil Electrical Insulation Putty

2.8 IDENTIFICATION

A. Comply with Section 230553, Identification for HVAC Piping and Equipment.

2.9 TANK GAUGING, LEAK DETECTION, AND OVERFILL MONITORING SYSTEM

A. Provide leak detection for fuel oil piping system as follows:

1. Leak detection cable within conduit piping system (for future leak monitoring by others).

B. Sensor cable shall be AGW-GOLD of fluoropolymer and polymer coated wire construction, with no exposed metal parts. Cable shall detect water-based, chemical and hydrocarbon liquids.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with applicable Missouri Department of Agriculture and Missouri Department of Natural Resources requirements.

B. Store and install equipment, pipe, controls, instrumentation, etc. in full accordance with manufacturer's instructions.

C. Where required, use only UL listed and labeled sealants approved for the fuel type for threaded fuel piping connections, dispenser base, etc.

3.2 STORAGE & HANDLING

A. Store and handle equipment, pipe, controls, instrumentation, etc. to prevent damage and exposure to detrimental environmental conditions.

B. Protect UV sensitive materials from direct sunlight.

C. Store materials in original packaging until installation.

D. Open ends of pipe shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system

3.3 CLEANING

A. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting prefabricated sections at field joints.

B. Conduit field joints shall be cleaned in accordance with manufacturer's instructions prior to installing fiberglass reinforced plastic jacket at conduit field joints.

3.4 INSTALLATION

A. Installation shall be completed by the manufacturer's certified installer in accordance with manufacturer's instructions and warranty requirements.

B. Comply with applicable codes, standards, and regulations.

C. Pipe shall be installed in clean condition and shall never be laid in chases with standing water.

1. The chase shall be continuously dewatered during installation.
2. Open pipe ends shall be protected with a hard cap or inflatable plug at the end of the workday.

D. Identification: Locate no more than 10' centers on top of pipe.

E. Pipe shall be installed with a continuous slope (minimum 1/8" per foot) such that any leaks in the primary pipe and secondary containment pipe will drain to building for leak detection.

F. Pipe shall be installed as direct as possible between termination points to facilitate inspection and replacement.

G. Pipe shall be installed with entry angle perpendicular to walls.

H. Pipe wall and floor penetrations shall be installed to prevent water infiltration with modular, watertight, flexible link-seal, penetration seal system with high temperature silicone rubber elements and stainless steel hardware.

I. Pipe shall be furnished and installed to permit integrity testing.

J. Prior to and upon completion of installation, inspect pipe materials for damage, cuts, scrapes, etc. Replace as required.

K. Complete integrity testing of piping system in accordance with manufacturer's instructions.

3.5 WELDING

A. Welding of field joints in carrier pipe shall be in accordance with the code for Pressure Piping, ANSI B31.1 (latest).

B. Welders and welding procedures shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

C. A record shall be maintained on the job showing the date and results of qualification test for each welder employed on the job.

D. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's Construction Representative.

E. Butt weld root pass (and second pass if required to prevent blow through) shall be by gas tungsten arc welding (GTAW).

F. All concealed carrier pipe field welds shall be tested for proper quality using nondestructive, testing procedures (ultrasonic or radiography) and the results interpreted by Contractor's independent testing company.

1. Testing shall be performed in accordance with Article 2 of Section V of the ASME Boiler and Pressure Vessel Code (latest edition) and interpreted in accordance with criteria set forth in ANSI B31.1.
2. Defective welds shall be repaired and the weld retested until it passes.
3. The independent testing company shall be arranged for and paid by the Contractor and approved by the Owner's Construction Representative.

G. Indicate all repaired welds on the Contractor's marked set of field drawings to be used to develop "as-builts."

3.6 CONDUIT FIELD JOINTS

A. Conduit field joints and FRP jackets shall be installed and tested in strict accordance with the conduit system manufacturer's instructions, and under supervision of manufacturer's field representative.

B. Installation of field joint steel casing and FRP jacket shall not proceed until results of tests on carrier pipe welds are received by Owner's Construction Representative and show the welds to be satisfactory.

3.7 FIELD TESTING

A. Carrier pipe shall be hydrostatically tested at 300 psig. Test pressures shall be held for not less than one hour.

B. Steel conduit shall be air tested at 10 psig, in accordance with manufacturer's instructions. Test pressures shall be held for not less than one hour.

C. Upon completion of the installation, the FRP jacket for the entire conduit system shall be spark tested in accordance with the manufacturer's instructions.

D. Jacket repairs shall comply with the manufacturer's instructions.

E. Testing shall be witnessed by Owner's Construction Representative.

F. All test results shall be recorded and submitted to Owner's Construction Representative.

3.8 CORROSION PROTECTIVE TAPE SYSTEM

A. Provide corrosion protection tape system on exposed, uncoated, carbon steel carrier piping.

B. Properly clean and dry pipe prior to installing tape system.

C. Prime pipe and fill irregular surfaces with putty.

D. Wrap weld beads with a prime layer of tape.

E. Apply tape with a spiral wrap per manufacturer's instructions.

F. Install additional protective overwraps as required to fully protect pipe.

3.9 TANK GAUGING, LEAK DETECTION, AND OVERFILL MONITORING SYSTEM

A. Install leak detection cable for future monitoring by others in accordance with manufacturer's instructions.

3.10 WARRANTY REGISTRATION DOCUMENTS

A. Complete and submit all site and warranty registration documents to all manufacturers as required to maintain manufacturers' warranty.

END OF SECTION 231113.20

SECTION 231330 – FUEL OIL DAY TANK – DIESEL ENGINE DRIVEN GENERATOR

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 SCOPE

A. The Contractor shall provide an indoor fuel oil day tank for an existing diesel-engine-driven generator set, along with all appurtenances, as specified herein and as shown on the Drawings.

B. Day tank shall be custom designed and fabricated to accommodate available space and requirements included in the construction documents.

1.3 RELATED SECTIONS

A. Section 230501 – General Mechanical Requirements for HVAC

B. Section 230513 - Common Motor Requirements for HVAC Equipment

C. Section 230900 - Instrumentation And Control For HVAC

D. Section 232000 – Piping for HVAC

1.4 SECTION INCLUDES

A. The work covered under this section shall include, but not be limited to, the following items:

1. Factory-packaged fuel oil day tank with spill containment basin and instrumentation and control system.
    a. With communication interface compatible with Owner's existing building automation system (BAS).
2. On site startup and testing
3. On site Owner training

1.5 SUBMITTALS

A. Submit shop drawings and product data.

B. Shop drawings shall include, but not be limited to, the following:

1. Factory published specification sheet indicating standard and optional accessories, ratings, etc.
2. Technical data sheet(s) identifying the make and model including relevant component design and performance data.
3. Breakdown of all components and options to be included.

4. Product data showing dimensions, weights, ratings, interconnection points, and wiring diagrams, control panel schematics.

5. Manufacturer's catalog cut sheets of all auxiliary components.

6. Dimension drawings (plans and elevations) showing overall measurements, mounting locations, and interconnect point for structural, mechanical, electrical connections.

7. Manufacturer's written warranty disclosure statement for the period specified.

C. Operation & Maintenance Manuals:

1. Provide O&M Manuals that describe installation, operation, and maintenance of the equipment furnished complete with all wiring and schematic diagrams within two weeks after the unit ships from the factory.

2. Manuals shall be conformed to "as-built" status by incorporating any and all changes made during the start-up period.

1.6 REFERENCES

A. The equipment covered by this section of the Specifications shall be designed, assembled and tested in accordance with the latest applicable codes, regulations, and standards, including, but not limited to:

1. The International Codes (I-Codes), developed by the International Code Council

2. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

3. ANSI/NEMA MG 1 – Motors and Generators

4. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

5. ANSI/NFPA 70 – National Electrical Code

6. IEEE 3005 – Emergency and Standby Power Systems

7. IEEE 3006 – Power System Reliability

8. NEMA 250 – Enclosures for Electrical Equipment (1000V Maximum)

9. NFPA 30 – Flammable and Combustible Liquid Code

10. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines

11. NFPA 101 – Life Safety Code

12. NFPA 110 – Emergency and Standby Power Systems

13. UL 142 – Steel Above Ground Tanks for Combustible Liquids

14. UL 508 – Industrial Control Equipment

15. UL 508A – Industrial Control Panels

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver to project site and store and protect products at the project site in accordance with manufacturer's recommendations.

B. Accept equipment and accessories on site and document any and all damage upon receipt at the project site.

C. Protect equipment from dirt and moisture.

1.8 PROJECT RECORD DOCUMENTS

A. Submit record documents.

B. Accurately record location of equipment and mechanical and electrical connections.

1.9 QUALIFICATIONS

A. *Manufacturer:* Company specializing in packaged engine-generator fuel oil day tank systems with minimum fifteen (15) years documented experience.

B. To qualify as a manufacturer, the complete equipment package must be a principal item manufactured by that manufacturer.

1.10 WARRANTY

A. Equipment shall be warranted for a minimum period of 1 year from the date of substantial completion of the project in accordance with the General Conditions.

1.11 FACTORY TESTS

A. The equipment manufacturer shall perform functional tests before shipping from the factory.

B. The test shall check equipment operation, vibration, pressures, temperatures, leaks, safety devices, etc.

C. Test runs shall be made over the full design load range.

D. Any defects that become evident during these tests shall be corrected before shipping.

E. Test reports shall be included with the shipment of the equipment to the project site and with O&M Manuals.

F. If the above testing is not available at the factory, the manufacturer's authorized service representative shall perform the tests and provide a test report as part of the start-up services.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with all requirements specified herein, provide products by one of the following:

1. Critical Fuel Systems
2. EarthSafe Systems

3. Preferred Utilities
4. Pryco, Inc.
5. Tramount
6. Or approved equal.

2.2 GENERAL

A. The packaged fuel oil day tank system shall be a coordinated assembly of compatible components.

B. All equipment and materials shall be new, and shall bear the Underwriters' Laboratories, Inc. (U.L.) Label of Approval, where applicable and available.

C. The equipment shall be UL Listed and Labeled.

D. Safety Standard: Comply with ASME B15.1.

E. Design parameters:

1. Site elevation ..... 900 ft.
2. Site Design air temperature range..... -20°F to 110°F
3. Fuel ..... No. 2 ULSD Diesel
4. Location ..... Indoors
5. Fuel supply pressure ..... +/- 60 psig
   a. Fuel supply pressure is controlled by an existing Fisher 98H backpressure regulator/relief valve at the discharge of existing duplex fuel oil supply pumps.
6. Fuel return pressure ..... +/- 10 psig
   a. Fuel return line is routed to existing above ground fuel oil supply tanks.
7. Existing Emergency Generator:
   a. 1985 vintage Caterpillar 3516 Diesel Engine Generator Set
   b. 1450 ekW Standby Rating
   c. Fuel Consumption at 100% Load = 124 gallons per hour.

F. Design Loads:

1. The equipment, as well as the means of fastening to the concrete foundation, shall be capable of withstanding gravity and seismic loads.
2. The International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures (current editions) shall be used as the design basis with specific environmental factors as stated below.
3. Comply with the ASCE Design Hazards Report for the site included in Attachment 1 to Section 230501 – General Mechanical Requirements for HVAC.
4. Earthquake Design Data:
   a. Occupancy Classification:

1) Power Plant: Moderate-hazard factory industrial, Group F-1

2) Correctional Center: Institutional Group I-3, Condition 5

b. Risk Category: IV

c. Seismic Importance Factor: Ie = 1.5

d. Site Class: D

e. Mapped Spectral Response Accelerations: $S_s = 0.23$, $S_1 = 0.1$

f. Spectral Response Coefficients: $S_{DS} = 0.2$, $S_{D1} = 0.14$

g. Seismic Design Category: D

h. Component Amplification Factor: $A_p = 2.5$

i. Component Response Modification Factor: $R_p = 2$

j. Overstrength Factor: $\Omega_o = 2$

k. Analysis Procedure: Equivalent Lateral Force ASCE 7

G. The equipment shall be mounted on a rigid structural steel base which shall provide adequate strength and rigidity to maintain alignment of mounted components.

H. Equipment shall be free from sharp edges and corners.

I. Include lifting attachments arranged for lifting with slings without damaging components.

J. *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.

K. Furnish a factory-packaged, complete and coordinated instrumentation and control system which provides all necessary interfaces between the new fuel oil day tank and the existing fuel oil supply pumps and the existing emergency generator diesel engine.

2.3 FUEL OIL DAY TANK - GENERAL

A. Diesel engine fuel oil day tank system shall be a factory-packaged, shop-tested, heavy duty, industrial, diesel fuel oil storage and transfer system, which is fully coordinated and operational with the existing diesel engine-generator and fits available space.

B. Fuel oil day tank shall provide an automatic, self-refilling, fuel supply system for an existing emergency diesel generator.

1. Day tank level switches and controller shall control day tank fuel oil supply valves.

a. Day tank level switches and controller shall also include provisions to start and stop Owner's existing fuel oil duplex pumps, which pump fuel oil from the Owner's existing above ground fuel oil tanks to the day tank and existing boilers.

2. Day tank high level switches and high level controller shall control day tank mounted reverse pump(s), which shall pump fuel oil to Owner's existing above ground fuel oil tanks.

C. Fuel oil day tank shall include all the required piping, instrumentation, control, and electrical systems to provide a fully functional system.

2.4 FUEL OIL DAY TANK

A. Fuel oil day tank shall be a factory-packaged, fuel oil supply system, suitable for indoor use for emergency generators.

B. Day tank shall be designed and constructed in accordance with UL Standards 142 and 508 and NFPA 30, 37, and 110.

C. Day tank and associated control system shall be UL 142 and 508 listed and labelled.

D. Day tank shall be provided with primary (inner) storage tank and secondary (outer) rupture basin sized for a minimum of 150% of primary tank capacity.

E. Both primary and secondary tanks shall be of heavy gauge (minimum 10 gauge), welded steel construction with corrosion resistant internal and external coatings.

F. Primary tank shall be a sealed and pressure tested single wall tank with minimum 5 psig pressure rating.

G. The primary tank shall have a capacity of 300 gallons of diesel fuel and shall be approximately 34” wide x 72” long x 52” high.

H. Secondary rupture basin shall be approximately 42” wide x 84” long x 42” high.

I. Piping shall comply with Section 232000 specifications for fuel oil supply and return piping.

J. All fuel oil supply piping and accessories shall have a minimum 200 psig working pressure rating at ambient temperatures and UL listing, unless approved otherwise by Engineer.

K. Tank connections shall be top-mounted, except for drains with plugs.

L. Day tank shall include, but not be limited to, the following accessories, instrumentation, and controls.

1. Control signal to existing duplex fuel oil supply pumps:
    a. Provide on/off signals for a future duplex fuel oil supply pump lead/lag controller.
        1) Provide two Form "C", double pole double throw (DPDT), dry contact relays.
            a) Relay 1 to signal lead pump start/stop.
            b) Relay 2 to signal lag pump start/stop.
        2) Contacts shall be rated for a minimum of 10 amps at 120 VAC.
    b. Existing duplex fuel oil supply pumps are currently manually controlled.
2. Reverse fuel oil rotary gear pump system
    a. For fuel oil return to existing above ground fuel oil storage tanks

b. Pump capacity shall be greater than the capacity of the fuel supply flow restrictor (specified below) at a minimum 50 psig discharge pressure.

c. Bronze or cast iron housing, self-adjusting mechanical, carbon ring seals, integral pressure relief valve, rigid steel base.

d. Pump shall be capable of 25" Hg suction vacuum at 0 psig discharge pressure as factory tested and of 15" Hg suction vacuum at 50 psig discharge pressure.

e. TEFC NEMA frame motors, with copper windings dynamically balanced rotor, ball bearings, heavy gauge steel NEMA frame, 120 V, single phase, 60 Hz.

f. Flexible coupling with OSHA guard.

g. Foot valve to prevent loss of pump prime.

h. Priming tee.

i. Viking or approved equal.

j. With 3" deep, steel, base pan with ½" NPT plugged drain connection.

k. Combination magnetic motor starter with overload protection and circuit breaker.

3. Fuel supply strainer, simplex, carbon steel body, 100 mesh, stainless steel, removable and cleanable, strainer basket, 1.5" NPT.

4. Fuel supply coalescer filter/water separator, 25 micron, simplex, carbon steel body, 1.5" NPT, lockable manual drain valve, manual vent, grounding lug, differential pressure gauge, water sight glass.

   a. Provide with two spare replaceable filter elements and gaskets.

5. Filter/Separator differential pressure switch and alarm.

6. Fuel Supply Flow Control Manifold, including but not limited to, the following:

   a. Fusable-link, fire safety, valve which automatically closes fuel line when ambient temperature reaches 165 F.

   b. Two, series-mounted, spring-return, fail-closed, 24 to 120V AC/DC, motorized, ball type, control valves with open/closed position switches, and manual override.

   c. Manual isolation ball valves upstream and downstream of motorized valves

   d. Manual bypass globe valve to manually fill day tank if motorized valves fail closed.

   e. Sight flow indicator – paddle wheel or propeller type with glass windows.

   f. Flow restrictor set for 500 gallons per hour (+/-8 gpm).

   g. Flow Switch – Indicate and Alarm – local/remote. (FS-31, FA-31)

7. Visual fuel level gauge (LE-01, LI-01)

8. Lead Fuel Level Control Switches – Control Valves Open/Closed, Lead Supply Pump On/Off.

a. Open/On - 70% Tank Capacity (LSL-11)

b. Closed/Off - 85% Tank Capacity (LSH-12)

9. Lag Fuel Level Control Switches – Control Valves Open/Closed, Lag Supply Pump On/Off

   a. Open/On - 60% Tank Capacity (LSL-13)

   b. Closed/Off – 85% Tank Capacity (LSH-14)

   c. Lag level switches shall be completely separate and independent of lead level switches.

10. The following low and high level alarm switches shall be completely separate and independent of lead/lag level control switches.

11. Critical Low Fuel Level Switch – Alarm – local/remote (LSL-21, LAL-21)

    a. 50% Tank Capacity

12. Critical Low Low Fuel Level Switch – Engine Shutdown, Alarm – local/remote (LSLL-22, LALL-22)

    a. 15% Tank Capacity

13. Critical High Fuel Level – Control Valves Closed, Supply Pumps Shutdown, Alarm – local/remote (LSH-23, LAH-23)

    a. 90% Tank Capacity

14. Critical High High Fuel Level – Reverse Pump On, Control Valves Closed, Supply Pumps Shutdown, Alarm – local/remote (LSHH-24, LAHH-24)

    a. 95% Tank Capacity

15. Over Fill Alarm – Alarm – local/remote (LSHH-25, LAHH-25)

    a. Float-operated vent pipe switch – normally closed, open on accumulation of liquid in vent line.

    b. Switch shall be mounted in vent pipe as close to the top of the tank as possible, no more than one foot.

16. Return Pump Flow Switch – Alarm – Local/Remote (FS-32, FA-32)

17. High Temperature Switch with Adjustable Dead Band – Reverse Pump On, Alarm – Local/Remote (TSH-41, TAH-41)

    a. Set Point on Temperature Rise: 130 F, adjustable.

18. Rupture basin leak detector - Supply Pump Shutdown and alarm – local/remote (LSH-51, LAH-51)

19. Primary tank supply pump connection – 2” x minimum 1” NPT with drop tube

20. Primary tank reverse pump connection – 2” x minimum 1” NPT with drop tube

21. Primary tank engine supply connection – 2” x minimum 1” NPT with drop tube and foot valve

22. Primary tank engine return connection – 2” x minimum 1” NPT with drop tube

23. Primary tank overflow – minimum 2” NPT

24. Primary tank normal vent – minimum 2” NPT

25. Primary tank normal vent cap – minimum 2" NPT, mushroom type, galvanized carbon steel with screen

26. Primary tank inspection port – minimum 6"

27. Primary tank emergency vent connection – size per NFPA requirements

28. Primary tank emergency vent cap, UL Listed with aluminum body; epoxy coated, weighted cast iron lid, zinc-plated steel shaft, Teflon coated seat, O-ring seal, maximum 0.5 psig opening pressure, maximum 2.5 psig full open pressure

29. Primary tank manual fill – 2" NPT with overfill prevention valve, cam-and-groove hose coupling, and lockable cap

30. Extra Connection – 2" NPT with plug

31. Primary Tank Drain – 1" NPT with plug

32. Rupture basin drain – 1" NPT with plug

33. Lift lugs

34. Anchor lugs

35. Rupture basin: primed and finished painted on interior and exterior

36. Primary tank: epoxy coating on interior, primed and finish painted on exterior

37. Enclosed, heavy gauge coated steel, industrial, microprocessor-based, control panel, which is UL 508A listed and labeled and NEMA 4 rated. The day tank control system shall operate on standard 120 VAC, single phase, 60 Hz power supply and shall include, but not be limited to, the following:

    a. Power supply status indicator

    b. AC/DC circuit breakers

    c. Power Supply surge protector

    d. Emergency stop switch

    e. Control system test/reset switch(es)

    f. LED indicators for all functions and alarms

    g. Manual/automatic fuel oil supply control valve and pump controls

    h. Control valve status indicators

    i. Fuel level sensors

    j. Motor control relays with LED signals

    k. Local alarm horn and flashing yellow light

    l. Alarm silence switch

    m. Alarm test switch

    n. Dry relay contacts (NO/NC) for remote annunciation of alarms, pump status, level status, and control system fault

    o. Self-diagnostics capabilities and fault logging

    p. "Key-pad" programmability

    q. Historical logs

r. Operator Interface Terminal (HMI): minimum 4" color touch screen for day tank status, alarms, historical logs, and trouble-shooting functions.

s. Backup means for the program, EPROM, or long life lithium battery, such that the system memory and program data is not lost in the event of a power failure.

t. Fail safe upon microprocessor failure.

u. Password protection against re-configuration by un-authorized personnel

v. Control panel shall be suitable for operation in a 20 F to 120 F, 0 to 95% relative humidity environment.

w. The control panel shall include Ethernet communications, Modbus TCP/IP (RJ45) or BACnet/IP, for interfacing with Owner's existing building automation system (BAS).

1) Coordinate with the existing BAS integrator as required in accordance with Section 230900 - Instrumentation and Control for HVAC.

38. Auxiliary Hand Fuel Pumps

a. An auxiliary hand pump shall be provided with the day tank for supplying fuel oil from 55 gallon drums, in the event that the normal fuel supply becomes disabled.

b. The auxiliary hand pump shall be piston or rotary type, and capable of pumping 20 gallons per 100 strokes, self-priming to 20' lift.

c. Auxiliary pump system shall include a 8' discharge hose, check valve, and telescopic suction tube.

2.5 GENERATOR CONTROL PANEL INTERFACE

A. Fuel oil day tank system shall provide signals to the Generator Control Panel as follows.

a. Fuel Oil Day Tank – Fill Failure Alarm

b. Fuel Oil Day Tank Low Level Alarm

c. Fuel Oil Day Tank High Level Alarm

d. Fuel Oil Day Tank Reverse Flow Switch Alarm

e. Fuel Oil Day Tank Overfill Alarm

f. Fuel Oil Day Tank High Temperature Alarm

g. Fuel Oil Day Tank Leak Alarm

h. Fuel Oil Day Tank Control System Fault Alarm

2.6 FACTORY TESTING

A. Primary tank shall be pneumatic tested to ensure tightness prior to shipment.

1. The minimum pressure for testing the tank shall be three (3) psi.

2. The pneumatic pressure shall be maintained until all joints and connections have been visually inspected for leaks, but in no case for less than one-half hour.

3. The tank shall not show any permanent deformation as a result of the test.

B. The Rupture basin (open top) shall be hydrostatic tested prior to shipment.

1. The basin shall maintain a full water level while all joints and connections are visually inspected for leaks.

2. The test shall be run for no less than one-half hour.

C. A copy of the test procedures shall be sent to the consulting engineer and owner.

D. The owners and or the consulting engineer, at their discretion, shall observe this and all other tests.

2.7 MISCELLANEOUS

A. All moving parts shall have metal guards to prevent entanglement of falling objects and provide personnel protection.

B. Furnish one (1) quart of the touch-up paint.

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 and referenced standards.

B. Install “shipped loose” items in accordance with the manufacturer’s written instructions and as indicated on the Drawings.

C. Provide field piping as required for a fully functional fuel oil supply system.

D. Provide conduit and wiring/cabling in accordance with the manufacturer’s written instructions and as indicated on the Drawings to connect the various components of the fuel oil day tank and the emergency power system together to make a complete and functioning system.

3.3 START-UP SERVICES

A. Field inspection and testing shall comply with manufacturer’s requirements and with NFPA 30, 37, and 110 requirements.

B. The equipment manufacturer shall provide the services of factory authorized field technician(s) for the following:

1. Verify that all equipment is installed properly
2. Check all auxiliary devices for proper operation
3. Test all alarms and safety shutdown devices for proper operation and annunciation
4. Check all fluid levels
5. Start equipment and check for proper operation, leaks, vibrations, etc.

C. The Engineer and the Owner shall be notified two (2) weeks in advance of the time and date of testing.

D. Submit test report(s) with test results and indicating time and date of testing and names of individuals present during testing to the Designer for record.

3.4 ADJUSTING

A. Adjust equipment and controls in accordance with manufacturer's requirements.

3.5 CLEANING

A. Clean equipment surfaces.

3.6 DEMONSTRATION

A. Provide systems demonstration.
1. Demonstrate that fuel oil day tank system operates properly.
2. Demonstrate that fuel oil day tank system interfaces properly with associated fuel oil supply pump system and emergency diesel engine generator system.

B. Coordinate the demonstration schedule with the Construction Representative and the Designer.

3.7 TRAINING

A. Provide four (4) hours of on-site training by factory trained field service engineer to instruct the Owner's personnel in the proper operation and routine maintenance of the equipment.

B. Review operation and maintenance manuals, parts manuals and emergency service procedures.

C. This shall be done after completion of the acceptance testing in two sessions, one in a.m. and one in p.m.

D. Training session shall be video recorded by the equipment manufacturer and two (2) copies of the video on DVD shall be provided to the Construction Representative.

END OF SECTION 231330

SECTION 232000 – PIPING FOR HVAC

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 SCOPE

A. The Contractor shall furnish and install all HVAC piping as shown on the Drawings and specified herein.

1.3 GENERAL

A. Piping shall be fabricated and installed in accordance with the Code for Pressure Piping, ANSI B31.1 (Latest) "Power Piping".

1.4 SUBMITTALS

A. Submit product data:

1. Piping materials
2. Solder filler metal for copper tube
3. Integrally reinforced branch fittings
4. Anti-sieze compound

B. Welder test reports.

C. Weld inspector qualifications.

D. Weld test reports.

E. Leakage test reports.

PART 2 - PRODUCTS

2.1 FABRICATION

A. Piping fabrication and materials for the various systems shall be in accordance with the schedule below and the piping specifications that follow this section.

Piping System	Symbol	Piping Specification No.
Drain	D	1
Vent	V	1
Glycol/Water Coolant	GLYCS/GLYCR	1
Fuel Oil	FOS/FOR	2
Engine Exhaust - Indoors	EEI	3
Engine Exhaust – Outdoors	EEO	4

B. All pipe materials shall be new, clean, and free of debris.

C. All pipe and large bore fittings shall be delivered to the site with plastic end caps.

PART 3 - EXECUTION

3.1 PIPE ERECTION

A. Carefully inspect all pipe, fittings, valves, equipment, and accessories prior to installation. Any items which are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

B. Pipe lines shall be run straight and true with a minimum use of joints and with only such offsets as may be required to clear interferences and to provide necessary clearance or headroom or provide the necessary flexibility in the piping system.

C. Changes in direction of pipe lines shall be made with approved fittings or pipe bends only.

D. Miter joints in welded pipe assemblies shall not be used except where shown on the Drawings.

E. Backing rings shall not be used on butt welded joints.

F. Tubing shall be installed with the use of tubing bends, to the maximum extent possible to minimize the use of fittings.

G. All prefabricated piping shall be arranged with extra tangent, loose flanges, field joints or other provisions to permit field adjustment to suit construction tolerances and to avoid interferences. No claims for extras for reworking prefabricated piping will be allowed other than for a major change in plans.

H. Provide flanges or unions at all final connections to equipment, traps, and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.

I. Pipe shall be cut to exact measurement and installed without springing or forcing. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or piping supports.

J. All cutting residue shall be cleaned from the interior of pipe prior to welding or joining.

K. All instrument tubing shall be run in a neat, straight fashion free from waves.

L. All flange bolts and nuts shall have threaded surfaces thoroughly coated with high temperature, anti-sieze paste. The paste shall be Nickel Grade Anti-Sieze (Lub-O-Seal Company, Inc.) or approved equal.

M. Flange bolts shall be properly tightened with torque wrenches to gasket manufacturer's requirements. See attachment to this specification.

N. Slugging wrenches and pneumatic impact wrenches shall <u>not</u> be used for tightening flange bolts.

O. All threaded pipe work is to be assembled with full threads, including all fittings, valves, unions, and specialties.

P. Threads shall be full and clean cut and the pipe shall be reamed and filed, removing all burrs from the interior.

Q. Threaded work shall be made up with a suitable pipe joint compound.

R. Mating flanges shall have same type face. Raised face flanges shall have raised portion machined off before bolting to flat face flanges.

S. All pipe shall be erected and supported in such a manner as to provide for expansion and contraction without harmful strain to the building structural members, pipe and pipe supports.

T. Consideration shall be given to insulation thickness when routing piping such that adequate clearance is provided to avoid interfering with insulation.

3.2 BRANCH CONNECTIONS

A. Branch connections shall be made with standard tees and 45° laterals of the type required for the service.

B. In place of standard tees and 45° laterals in black steel piping systems, Contractor may use integrally reinforced weld-on fittings only where specifically shown on the Drawings.

C. Integrally reinforced branch connections shall maintain full pipe strength and shall comply with ANSI B31.1, ANSI B16.9, and MSS-SP-97 Standard – Integrally Reinforced Forged Branch Outlet Fittings. Fittings shall be Bonney Forge Weldolet or approved equal.

3.3 DRAINING AND VENTING

A. Unless otherwise indicated on the Drawings, all horizontal lines, including runouts and branches, shall pitch to low points to provide for complete drainage or removal of condensate and venting. Slope unless otherwise indicated, shall be 1" in 40'.

B. Maintain constant slope where lines are pitched for venting and drainage. No lines shall have pockets due to changes in elevation unless indicated on the Drawings. In such instances proper provisions for draining and venting shall be provided.

C. Provide 3/4" drain valves fitted with 3/4" hose thread adapter at all low points of process or water piping systems and where indicated on Drawings to permit complete or sectionalized draining.

D. Provide manual air vents with 3/4” vent valves at the high points of piping systems and where shown on Drawings.

3.4 SLEEVES

A. Furnish and install sleeves for all pipes passing through floors and walls, slabs, grade beams and foundations.

B. When possible, layout, size and locate all sleeves such that they are installed prior to pouring concrete or when masonry is being constructed.

C. Sleeves shall be standard weight galvanized steel pipe, or 10-gauge galvanized sheet metal to be closed with longitudinal weld joint, having square cut ends with anchoring lugs welded on.

D. Horizontal sleeves through walls, grade beams, foundations and partitions shall be grouted in place and shall be flush with finished wall faces.

E. Vertical sleeves through floors shall extend 2" above finished floor and be flush on under side.

F. Size sleeves such that internal diameter is 2" larger than O.D. of bare pipe for uninsulated lines and 2" larger than O.D. of insulation and jacket for insulated lines.

G. Center pipes in sleeves. Sleeves in pits or below grade shall be painted or coated with one coat of coal tar paint.

H. Roof openings shall have collars flashed into roofing system and weather hoods attached to pipe as shown on the Drawings. Final detail shall comply with roofing manufacturer's requirements.

3.5 FIRE-RESISTANCE-RATED ASSEMBLY PENETRATIONS

A. Fire-Resistance-Rated Assembly Penetrations: Where pipes pass through fire-resistance-rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained by special sealers and materials for through-penetration fire stop systems.

3.6 DIELECTRIC CONNECTIONS

A. Pipe joints connecting dissimilar metals shall be insulating, dielectric connections. Such joints, including dielectric material, shall be rated to withstand the temperature, pressure, and other characteristics of the service for which it is to be used, including testing pressure.

B. Screwed joints shall be made with insulating unions and couplings.

C. Flanged joints shall be made up with flange insulation kits consisting of a suitable gasket, bolt sleeves and washers.

3.7 WELD TESTING

A. The Contractor shall test all pipe welds for proper quality using nondestructive, ultrasonic testing procedures in accordance with the applicable ANSI/ASME codes.

1. Testing will be completed by Contractor’s third party, certified weld inspector, subject to approval of Construction Representative and Engineer.

B. Contractor shall complete any required repairs at Contractor’s cost.

3.8 LEAKAGE TESTING

A. Tests shall be performed and approval of tests obtained in writing prior to cleaning, backfilling, insulating, painting, or concealing pipe.

B. Notify Owner’s Representative 24 hours in advance of testing.

C. Prepare and keep records of each system or section of system tested. Test reports shall be signed as approved by Owner's Representative with four (4) copies to Owner's Representative. If additional copies are required by those persons having legal jurisdiction, Contractor shall furnish them. Test reports shall include, but not necessarily be limited to, the following.

1. Identification of piping system or section tested.
2. Date of test and date of Owner's Representative approval signature.
3. Testing medium and method or description of test procedure.
4. Test pressure, duration of test and recorded pressure drop.

D. Pressure tests shall apply to piping only with all equipment, traps, relief valves and instruments blocked off or disconnected. In no case shall piping or any component be subjected to pressures exceeding 90% of their published rating. All system valves within section being tested shall be open. Provide temporary restraints on expansion joints and flexible connections during pressure testing.

E. The Contractor shall provide all compressors, pumps, gauges, pipe, fittings, closures, etc., required for the tests. Blanks shall be furnished and installed wherever necessary to prevent cold test water from coming in contact with hot valves. Remove blanks after testing.

F. Unless otherwise indicated hydrostatic testing medium shall be potable water and pneumatic testing medium shall be compressed air.

G. Pneumatic testing for any purpose shall require evacuation of all personnel not directly involved in performing test and preliminary test of 25 psig. Swab all joints with standard high film strength soap solution and check for bubbles.

H. Pneumatic tests may be substituted for specified hydrostatic tests where freezing conditions may occur when approved by Owner's Representative.

I. Hydrostatic and pneumatic tests shall apply to piping as indicted in the following schedule.

1. The pressure shall be gradually raised to the value given and the source then blocked off.
2. Pressures shall be observed after the pipe and contents have stabilized at the ambient temperature and the source of test pressure shut-off.
3. All joints shall be visually examined during test.
4. Leaks shall be repaired and complete testing procedure repeated.
5. Upon successful completion and approval of the tests, the piping shall be relieved of pressure, drained, dried, cleaned and put into normal operation except for potable water which shall first be disinfected.

LEAKAGE TEST SCHEDULE

Service	Operating Pressure psig	Hydrostatic Test Pressure psig	Minimum Time Hours
Coolant (GLYCS/GLYCR)	to 50	75	2
Fuel Oil (FOS/FOR)	to 100	150	2

J. All new piping not specifically listed above shall receive an initial service leak test by gradually bringing the system up to normal operating pressure for at least 10 minutes while examining for leaks.

3.9 CLEANING

A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil, and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice. Chips and burrs from thread cutting operations shall be blown out of pipe before assembly. Cutting oil shall be removed from internal and external surfaces.

B. During fabrication and assembly, slag and weld spatter shall be removed from pipe joints by peening, chipping, and wire brushing.

C. Contractor shall arrange for visual inspection of all pipe by Owner's Representative prior to closure.

D. All completed piping systems except those listed immediately below shall be cleaned:

1. Vent
2. Drain

E. Notify Owner's Representative prior to starting any cleaning operation. Consult with Owner's Representative with regard to scheduling.

F. It shall be Contractor's responsibility to arrange for proper disposal of cleaning and flushing fluids.

G. Prior to blowing or flushing piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

H. Water Flush: Flush pipe and components with clean water until all discharge from system is clean. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of lines, ends of headers and as otherwise required to flush entire system. Water flush shall apply to the following systems:

1. Coolant (GLYCS/GLYCR)

    a. Comply with engine and radiator manufacturers' requirements for cleaning and flushing coolant system.

I. Oil Flush: Flush pipe and components with the service fluid until the discharge from each system is clean. Flow shall be in the same direction as when system is in normal operation. Used cleaning fluid shall be drained into containers. These containers shall be disposed of off the job site by Contractor in a manner which fully complies with all federal, state, and local pollution regulations. Oil flush shall apply to the following systems:

1. Fuel Oil (FOS/FOR)

J. Air Blow: Blow out pipe and components with dry oil free air, or nitrogen. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blow out points is clean. Use 80-90 psig pressure unless otherwise indicated. Air blow cleaning

shall require evacuation of all personnel not directly involved in the cleaning operation. Air blow shall apply to the following systems:

1. Fuel Oil (FOS/FOR) (as an alternative to oil flush).

K. Following flushing or blowing operations, all items disconnected or blanked off shall be reconnected. Strainer screens shall be removed, cleaned, and replaced.

L. Repeat cleaning as required to obtain a contamination-free system.

3.10 START-UP

A. After each installation is completed, tested for leaks, cleaned, and approved by the Owner's Representative, it shall be filled with the fluid it is to carry.

B. Purge piping of all air during filling with operational fluid.

C. Prime piping with operational fluid, as required.

D. Inspect piping systems during filling, start-up, and initial operation. Inspections shall include, but not be limited to, the following:

1. Leaks
2. Support system performance
3. Thermal expansion system performance
4. Unexpected deflections or deformations
5. Proper levels, flow, temperatures, and pressures
6. Unusual noises, vibration, cavitation, etc.

E. Address issues as required.

3.11 FINAL INSPECTION AND ADJUSTING

A. The Contractor shall then test each system in actual operation, operate all valves, safety devices and equipment which he has installed and make final adjustments to place the system in operation.

B. Such operation shall be demonstrated to the satisfaction of the Owner's Representative.

PIPING SPECIFICATION NO. 1

General Use: Drain (D)
Vent (V)
Coolant (GLYCS/GLYCR)

Fabrication: 2" and under: Threaded
2-1/2" and above: Welded and Flanged

Pipe: Seamless Carbon Steel, ASTM A53 or A106, Grade B, ANSI B36.10
2" and under: Schedule 80
2-1/2" and above: Schedule 40 to 10", 0.375" wall for 12" and above.

Fittings: 2" and under: Class 2000, forged steel, threaded fittings, ASTM A105, ANSI B16.11.

2-1/2" and above: Butt welding, carbon steel, ASTM A234, ANSI B16.9

Elbows to be long radius for 12" or lower diameter pipe unless otherwise shown on the Drawings.

Elbows to be short radius for 16" or greater diameter pipe unless otherwise shown on the Drawings.

Use Standard Weight with Schedule 40 and 0.375" wall pipe, Extra Heavy with Schedule 80 pipe.

Unions and Flanges: Unions: Class 2000 forged steel, threaded, ASTM A105, ANSI B16.11, MSS-SP-83.

Flanges: Class 150, forged steel, welding neck, ASTM A105, ANSI B16.5 (24" or less), ANSI B16.47 Series A (26" – 30"), raised face with surface finish suitable for the specified gasket.

Gaskets: Stainless alloy spiral wound gasket, non-asbestos, Class 150, 0.175 inch thick, Flexitallic CGI, 304 SS/"Flexicarb".

Bolting: ASTM A193, Grade B7 alloy steel stud bolts, ASTM A194 Grade 2H heavy semi-finished hex nuts.

Notes:
1. Backing or chill rings are not allowed.
2. For coolant (GLYCS/GLYCR) piping butt weld joints, the root pass and second pass shall be by gas tungsten arc welding (GTAW).
3. Note pipe weld inspection requirements in this Section and Section 230501, General Mechanical Requirements for HVAC, paragraph 3.6, Thermal Metal Joining and Cutting.

PIPING SPECIFICATION NO. 2

General Use: Fuel Oil (FOS/FOR)

Fabrication: 2" and under: Socket Welded
2-1/2" and above: Butt Welded and Flanged

Pipe: Seamless Carbon Steel, ASTM A53 or A106, Grade B, ANSI B36.10
2" and under: Schedule 80
2-1/2" and above: Schedule 40 to 10", 0.375" wall for 12" and above.

Fittings: 2" and under: Class 3000, forged steel, socket weld fittings, ASTM 105, ANSI B16.11.

2-1/2" and above: Butt welding, carbon steel, ASTM A234, ANSI B16.9

Elbows to be long radius for 12" or lower diameter pipe unless otherwise shown on the Drawings.

Elbows to be short radius for 16" or greater diameter pipe unless otherwise shown on the Drawings.

Use Standard Weight with Schedule 40 and 0.375" wall pipe, Extra Heavy with Schedule 80 pipe.

Unions and Flanges: Unions: Class 3000, forged steel, socket weld, ASTM A105, ANSI B16.11, MSS-SP-83.

Flanges: Class 150, forged steel, welding neck, ASTM A105, ANSI B16.5 (24" or less), ANSI B16.47 Series A (26" – 30"), raised face with surface finish suitable for the specified gasket.

Gaskets: 1/16" compressed graphite fiber with nitrile binder, fire safe, Garlock G-9900.

Bolting: ASTM A193, Grade B7 alloy steel stud bolts, ASTM A194 Grade 2H heavy semi-finished hex nuts.

Notes:

1. Backing or chill rings are not allowed.
2. Note pipe weld inspection requirements in this Section and Section 230501, General Mechanical Requirements for HVAC, paragraph 3.6, Thermal Metal Joining and Cutting.
3. Above-ground fuel oil piping systems shall be listed and labeled in accordance with UL1369, Standard For Aboveground Piping For Flammable And Combustible Liquids, and shall comply with International Mechanical Code, NFPA 30, Flammable and Combustible Liquids Code, and NFPA 31, Standard for the Installation of Oil-Burning Equipment.

PIPING SPECIFICATION NO. 3

General Use: Engine Exhaust (EEI) – Indoors (Note 1)

Design Conditions: 10 psig at 1000 F.

Fabrication: 2" and under: Threaded
2-1/2" and above: Butt Welded and Flanged

Pipe: Seamless or ERW, Alloy Steel, ASTM A335, Grade P11, ANSI B36.10
2" and under: Schedule 80
2-1/2" and above: Schedule 40 to 10", 0.375" wall for 12" and above

Fittings: 2" and under: Class 2000, forged alloy steel, threaded fittings, ASTM A182, Grade F11, ANSI B16.11.

2-1/2" and above: Butt welding, alloy steel, ASTM A234 Grade WP11, ANSI B16.9, ANSI B36.10

Elbows to be long radius for 12" or lower diameter pipe unless otherwise shown on the Drawings.

Elbows to be short radius for 16" or greater diameter pipe unless otherwise shown on the Drawings.

Use Standard Weight with Schedule 40 and 0.375" wall pipe, Extra Heavy with Schedule 80 pipe.

Unions and Flanges: Unions: Class 2000, forged alloy steel, threaded, ASTM A182, Grade F11, ANSI B16.11, MSS-SP-83.

Flanges: Class 150, forged alloy steel, welding neck, ASTM A182, Grade F11, ANSI B16.5 (24" or less), ANSI B16.47 Series A (26" – 30"), raised face with surface finish suitable for the specified gasket.

Gaskets: Stainless alloy spiral wound, non-asbestos gasket, Class 150, 0.175-inch-thick, Flexitallic CGI, 316L SS/"Thermiculite 835 Series", 316L outer ring, 316L steel inner ring, ASME B16.20.

Bolting: ASTM A193, Grade B7 alloy steel stud bolts, ASTM A194, Grade 2H heavy hex nuts.

Notes:

1. Transition to EEO piping 12" inside exterior wall or roof lines.
2. Comply with ANSI/ASME B31.1 requirements for weld preheat, post-weld heat treatment, inspection, examination, and testing. Submit a list which summarizes these requirements.
3. Backing or chill rings are not allowed.
4. Note pipe weld inspection requirements in this Section and Section 230501, General Mechanical Requirements for HVAC, paragraph 3.6, Thermal Metal Joining and Cutting.

PIPING SPECIFICATION NO. 4

General Use: Engine Exhaust (EEO) – Outdoors (Note 1)

Design Conditions: 10 psig at 1000 F.

Fabrication: 2" and under: Threaded
2-1/2" and above: Butt Welded and Flanged

Pipe: Seamless or ERW, 316L Stainless Steel, ASTM A312-TP316L, ANSI B36.10
2" and under: Schedule 80
2-1/2" and above: Schedule 40 to 10", 0.375" wall for 12" and above.

Fittings: 2" and under: Class 2000, forged 316L stainless steel, threaded fittings, ASTM A182 F316L, ANSI B16.11.

2-1/2" and above: Butt welding, 316L stainless steel, ASTM A403-WP316L, ANSI B16.9, ANSI B36.10

Elbows to be long radius for 12" or lower diameter pipe unless otherwise shown on the Drawings.

Elbows to be short radius for 16" or greater diameter pipe unless otherwise shown on the Drawings.

Use Standard Weight with Schedule 40 and 0.375" wall pipe, Extra Heavy with Schedule 80 pipe.

Unions and Flanges: Unions: Class 3000, forged 316L stainless steel, integral seat, threaded, ASTM A182, Grade F316L, ANSI B16.11, MSS-SP-83.

Flanges: Class 150, forged 316L stainless steel, welding neck or slip-on, ASTM A182, Grade F316L, ANSI B16.5 (24" or less), ANSI B16.47 Series A (26" – 30"), raised face with surface finish suitable for the specified gasket.

Gaskets: Stainless alloy spiral wound, non-asbestos gasket, Class 150, 0.175-inch-thick, Flexitallic CGI, 316L SS/"Thermiculite 835 Series", 316L outer ring, 316L steel inner ring, ASME B16.20.

Bolting: ASTM A193, Grade B8M CL 2, stainless steel stud bolts, ASTM A194, Grade 8M CL 2, stainless steel, heavy hex nuts, Class 2B threads.

Notes:

1. Transition to EEO piping 12" inside exterior wall or roof lines.
2. Comply with ANSI/ASME B31.1 requirements for weld preheat, post-weld heat treatment, inspection, examination, and testing. Submit a list which summarizes these requirements.
3. Backing or chill rings are not allowed.
4. Note pipe weld inspection requirements in this Section and Section 230501, General Mechanical Requirements for HVAC, paragraph 3.6, Thermal Metal Joining and Cutting.
5. Butt welds shall be by gas tungsten arc welding (GTAW) with inert gas (argon/helium) purge.

6. Weld procedures shall maintain corrosion resistance in weld-affected zone equal to corrosion resistance of base material.
7. Provide dielectric connections at joints between stainless steel, carbon steel and copper piping materials.

END OF SECTION 232000

SECTION 232116 – PIPING SPECIALTIES

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 SCOPE

A. Contractor shall furnish and install all piping specialties as shown on the Drawings and specified herein.

1.3 SUBMITTALS

A. Manufacturer's data sheets

B. Performance Curves

C. Motor Data

D. Wiring Diagrams

E. Factory Test Reports

F. Factory Calibration Reports

G. Field Calibration Reports

H. Field Inspection Reports

1.4 QUALITY CONTROL

A. Instruments shall be factory calibrated with devices traceable to the National Institute of Standards and Technology (NIST).

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Pressure gauges shall be furnished and installed as called for on the Drawings.

B. Pressure gauges shall be 1/2% accuracy with stainless steel movement, black polypropylene case, 4-1/2" diameter dial, solid front, blowout back, and 1/2" NPT connection. Gauges shall be Ashcroft, Trerice, Weiss, Weksler, Miljoco, or Palmer.

C. Unless otherwise warranted by the service requirements, bourdon tube shall be bronze or stainless steel for service temperatures less than 250^{o}F and stainless steel for service temperatures at or above 250^{o}F.

D. Unless otherwise noted, all gauges shall have 1/2” carbon steel, bar stock needle valve with hard faced seats, Teflon packing, blow-out proof stem, suitable for the service conditions.

E. Gauges used on service temperatures above 120 F shall be protected with pigtail siphons.

F. Outdoor gauges shall be liquid filled with silicone suitable for -40°F to +150°F ambient temperatures and -40 F to 200 F process temperatures with IP 66 enclosure rating.

G. Pressure gauges shall be as follows. Quantities shall be determined by the drawings.

Tag	Service	Service Pressure (psig)	Service Temperature (°F)	Scale (psig)
PI-1	Coolant (GLYCS/GLYCR)	0 – 15	0 - 250	-30" Hg – 30
PI-2	Fuel Oil Supply (FOS)	0 - 60	0 - 120	0 - 120
PI-3	Fuel Oil Return (FOR)	0 - 10	0 - 120	0 - 20

2.2 THERMOMETERS

A. Thermometers shall be furnished and installed as called for on the Drawings.

B. Thermometers shall be the hermetically sealed bimetallic type with 1% full span accuracy, ½" NPT connection stainless steel case, external adjustment and "every angle" feature. Thermometers shall have 3" to 5" dial and be furnished with separable stainless steel thermowell.

1. Thermowell shall have ¾" process connection.
2. Provide extended neck as required for use on insulated pipe.
3. Thermometers in outdoor service shall be of weatherproof construction suitable for service from 0°F to 150°F, ambient.

C. Stem of thermometer and length of thermowell shall extend to the center of the pipe or a minimum of 4" into the pipe.

D. Furnish heat transfer gel with thermometers.

E. Thermometers shall be Aschroft "EI," Palmer "Model 5A," Trerice "B856 Series," Weiss "Model 5VBM," or Weksler "Type AF."

F. Thermometer scale range shall be as follows:

1. TI-1: Coolant (GLYCS/GLYCR): 0 to 300° F.

2.3 FLEXIBLE CONNECTORS

A. Provide flexible connectors as shown on the Drawings and specified herein.

B. FC-1: Flexible connector for fuel oil piping shall be NFPA 30/30A compliant, metal type complying with UL 2039, Flexible Connector Piping for Fuels, UL Listed and Labeled.

1. Flexible connector shall be corrugated 316L/321 stainless steel inner core with 304L stainless steel braid and braid collar.

2. End fittings shall be stainless steel, hex male x hex male NPT, rated for 150 psig working pressure and full vacuum at 70°F.

3. Flexible connection shall be 12” long unless noted otherwise on the Drawings.

4. Connector shall be Hose Master Fire-Shield, or approved equal by Franklin Fueling Systems, Flex-Hose Co. Inc., Minnesota Flexible Corporation, OmegaFlex, OPW Fueling Components.

C. FC-10: Flexible connector for glycol-water coolant service shall be 300 series stainless steel, corrugated hose with 300 series stainless steel double braid.

1. Connections 2” or less shall be carbon steel, schedule 40, male NPT.

2. Connections 2-1/2” and larger shall be ASTM A105, carbon steel, ANSI Class 150, flanged ends.

3. Connector shall have working pressure rating of no less than 150 psig at 300 F and shall be rated for no less than 1/2" lateral movement at minimum 1000 cycles.

4. Overall length shall be about 12” inches.

5. Connector shall be Flexicraft, Hyspan, Metraflex, or approved equal.

2.4 STRAINERS

A. Furnish and install strainers as shown on the Drawings. Unless otherwise indicated or specified, strainer shall be Y-pattern with 304 stainless steel screen having .045” openings.

B. Strainers shall be as follows:

1. ST-10: Flanged, Class 125, cast iron, ASTM A126 Class B, with blowoff port & plug, rated for 125 psig at 450 F, 100 mesh screen reinforced by perforated 304SS screen, composition gasket, Keckley A7 or approved equal by Armstrong, Titan, Watts, or Wheatley.

2.5 ANTI-SIPHON VALVE (SP-1)

A. Provide anti-siphon valves as shown on the drawings and specified herein.

B. Anti-siphon valve shall automatically shut off oil flow in the event of a broken or open suction line.

C. Anti-siphon valve shall be UL Listed, heavy duty bronze body with oil proof gasketing, spring loaded poppet, tight shut-off composition seat, and dash pot. Valve shall be suitable for 7’ of hydrostatic head as measured vertically from the top of the tank to the pump inlet. Valve shall be suitable for installation with No. 2 fuel oil.

D. Anti-siphon valve shall be Preferred Utilities, Model A, or approved equal.

2.6 SPILL RESPONSE KIT – OIL

A. Provide OSHA-compliant spill response kit for emergency generator room suitable for oil-based liquids such as hydrocarbons, fuel, and grease.

B. SRK-O1: Kit shall include the following:

1. Quantity = 1

2. 12 gallon Absorbency Capacity
3. 30 16" x 20" Pads
4. 4 3" x 4' Socks
5. 5 Disposable Bags
6. Light Stick
7. Pair of Goggles
8. Pair of Nitrile Gloves
9. Stick of Repair Putty

C. Spill response kit shall be Seton DAWG Oil Only Spill Kit or approved equal.

2.7 SPILL RESPONSE KIT - UNIVERSAL

A. Provide OSHA-compliant spill response kit for emergency generator room suitable for non-hazardous types of liquids like water, coolants, antifreeze and solvents.

B. SRK-U1: Kit shall include the following:

1. Quantity = 1
2. 7.5 gallon Absorbency Capacity
3. 20 16" x 20" Pads
4. 2 3" x 4' Socks
5. Disposable Bags
6. Pair of Nitrile Gloves

C. Spill response kit shall be Seton DAWG Oil Universal Spill Kit or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping specialties in full accordance with manufacturer's instructions.

3.2 FLEXIBLE CONNECTORS

A. To insure proper joint alignment, the piping shall be made up "solid" and anchored and then a section of pipe shall be cut out and the connector installed into the pipe line.

B. Install unions on both ends of flexible connectors with threaded connections.

C. Do not compress or extend axially, torque, or allow movement in multiple plans.

D. Use pipe elbows to avoid sharp bends in connector. Maintain manufacturer's minimum centerline bend radius.

E. Properly support and anchor piping to prevent pipe gravity and pressure thrust loads on flexible connectors.

3.3 INSTRUMENTS

A. Field check instrument calibration with devices traceable to National Institute of Standards and Technology (NIST).

B. Gauges shall be installed so as to be visible from adjacent walkways, platforms, etc.

C. Thermometers shall be installed so as to be visible.

D. Thermowell shall be filled with heat transfer gel prior to inserting thermometer stem.

E. For thermometers in pipe diameters 2" or less, install a minimum 2-1/2" x 2-1/2" tee with appropriate bushings, reducers, nipples, etc., in the line pipe.

1. Install the well into the tee with appropriate bushing nipples, caps. etc., as required to obtain thermowell insertion to pipe centerline without causing a flow restriction.

3.4 STRAINERS

A. Clean all strainers after completion of start-up.

3.5 ANTI-SIPHON VALVE (SP-1)

A. Install anti-siphon valve in a vertical position in the highest point in the suction line, in strict accordance with manufacturer's instructions.

B. Prime pipe upstream and downstream of anti-siphon valve with fuel oil prior to system start-up.

3.6 SPILL RESPONSE KIT - UNIVERSAL

A. Install spill response kits with instructions as directed by Owner’s Representative.

END OF SECTION 232016

SECTION 233100 – HVAC DUCTS AND CASINGS

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 SCOPE

A. Contractor shall furnish and install all ducts and accessories as shown on the Drawings and specified herein.

1.3 GENERAL

A. Where wording used herein concerns sheet metal trades terminology, such as joint connections and construction or fabrication techniques, etc., the accepted definition of the terminology shall be as described and pictured in current edition of the SMACNA duct manuals.

1.4 SUBMITTALS

A. Submit manufacturer's product data sheets and start-up performance documentation for all materials and products.

B. Submit general arrangement and fabrication drawings which coordinate new equipment, ducts, and accessories with existing conditions.

PART 2 - PRODUCTS

2.1 SHEET METAL DUCTWORK

A. Unless otherwise indicated, materials shall conform to the following:

	Sheet and Strip Material	ASTM Specification
1.	Galvanized steel, coating G90	A-527

B. Ductwork and ductwork accessories shall be constructed in accordance with SMACNA HVAC Duct Construction Standards (latest edition) for pressure of +/- 4" w.g.

C. All four sides of a duct are to be constructed from the same gauge of sheet metal that is dictated by the greatest cross sectional dimension.

D. Duct sides over 18 inches wide having unreinforced panel areas over 10 square feet must be cross-broken, headed, or suitably braced, stiffened and reinforced.

E. Stiffeners, reinforcing, bracing, supports, tie rods, rivets, screws, bolts, nuts and accessories used in direct contact with ductwork shall be of materials identical to the duct unless indicated otherwise.

2.1 DUCT SUPPORT STRUCTURAL STEEL

A. Wide flange beams shall be ASTM A992 (50 ksi minimum yield stress).

B. Miscellaneous structural steel, plates, etc. for pipe supports and anchors in trenches and manholes shall be ASTM A36 (36 ksi minimum yield stress) of sizes and shapes as shown on the Drawings.

C. Structural tubing shall be ASTM A500, Grade B (46 ksi minimum yield stress).

D. Welding of structural steel supports and anchors shall be completed with E70XX electrodes.

E. All outdoor structural steel shall be hot-dipped-galvanized in accordance with ASTM A123, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2.2 EXPANSION BOLTS

A. Expansion bolts and nuts used in connection with support structures shall be stainless steel, Hilti "KWIK BOLT TZ2" or approved equal by Powers or Red Head, installed per manufacturer's recommendations. Embedment shall be as follows, unless noted otherwise:

Bolt Diameter, in.	Embedment, in.
½	4
5/8	4
3/4	6
1	6

2.3 ADHESIVE ANCHORS

A. Anchors for fastening to concrete shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge and 304SS anchor bolts with washer and nut, Hilti HIT HY200 with HIT-Z-R anchor bolt with minimum 6" embedment, or approved equal by Powers or Red Head.

B. Anchors for fastening to masonry shall be adhesive type consisting of a two-part resin adhesive contained in a cartridge, 304SS screen tube (for hollow construction) and 304SS thread rod with washer and nut, Hilti HIT HY20 or approved equal by Powers or Red Head.

C. Pipe supports from masonry shall be installed only after review and approval by the Engineer.

PART 3 - EXECUTION

3.1 COORDINATION

A. Field verify existing conditions.

B. Coordinate new ducts and casings with equipment and existing conditions.

3.2 FABRICATION AND ERECTION

A. Construct ductwork square with all sharp edges and protrusions removed.

B. Support and brace ductwork rigidly to prevent vibration.

C. Unless specifically shown on Drawings or specified herein, piping, electrical conduit, building elements, etc., shall not come in contact with or pass through ducts.

D. No obstructions, unless detailed on the Drawings, shall be allowed inside of ductwork.

E. Route ductwork directly avoiding all unnecessary directional changes and abrupt transitions.

F. Install ducts and hangers straight, plumb and level.

G. Provide adequate space around ducts to assure proper support.

H. Openings for ducts or pipes passing through building roof shall be curbed and flashed water tight.

I. Install all ductwork accessories in accordance with SMACNA and ASHRAE standards.

3.3 HANGERS AND SUPPORTS

A. Supports for ductwork and accessories shall be installed in a manner that will not result in or produce excessive stress, deflection, swaying, sagging or vibration in the ductwork or in the building structure either during erection, cleaning, testing or normal operation of the system.

B. Provide seismic restraints in accordance with the International Building Code (current edition) and SMACNA.

C. However, ductwork shall not be so restrained as to cause it to snake or buckle between supports or anchors or to prevent movement due to expansion and contraction.

D. Ductwork shall be installed at equipment such that equipment can be disconnected and removed without further supporting the ductwork.

E. Ductwork shall not introduce any strains or distortions to the connected equipment.

F. Hangers and supports shall be installed complete, including lock nuts, rods, bolts, couplings, swivels, inserts, secondary steel and required accessory items.

G. All hangers, supports, clamps, and angles in contact with the ductwork shall be of the same material as the duct.

H. All bolts, nuts, washers, screws, and other fasteners shall be cadmium plated, stainless steel or otherwise corrosion resistant.

1. Outdoor hardware shall be hot-dipped-galvanized or stainless steel.

3.4 WELDING AND BRAZING

A. All surfaces to be joined by welding or brazing shall be cleaned of grease, oil, dirt, oxidation or other foreign substance.

B. Exercise care to avoid burning through sheet metal.

C. Galvanized Steel:

1. On ductwork 16 gauge and heavier use filler rods in accordance with specification for iron and steel gas welding rods ASTM A251-AWS A5.2.

2. On ductwork 18 gauge and lighter use filler rods in accordance with specifications for brazing filler metals ASTM B260-AWS 5.8.

3. After completion of welding on galvanized ducts, apply one coat of cold galvanizing paint to exterior surfaces affected by the weld heat.

3.5 JOINTS

A. Ductwork shall be sealed air tight by means of gaskets, liquid sealant, sealing tape, or welding.

B. Joints between flexible connection and duct or fan shall be sealed with duct sealer.

C. Flexible connections shall fit tightly around ducts and fans and shall be securely bolted in place.

END OF SECTION 233100

SECTION 233313.33 – VOLUME-CONTROL DAMPERS

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 SCOPE

A. Contractor shall furnish and install all HVAC dampers as shown on the Drawings and specified herein.

1.3 GENERAL

A. Where wording used herein concerns sheet metal trades terminology, such as joint connections and construction or fabrication techniques, etc., the accepted definition of the terminology shall be as described and pictured in current edition of the SMACNA duct manuals.

B. Multi-section dampers shall be provided with horizontal and vertical bracing to support damper weight and system pressure.

1. Bracing shall be designed by damper manufacturer or by Contractor's Missouri professional engineer.

2. Bracing shall be suitable for 30 lb/ft^2 or maximum differential pressure rating, whichever is higher.

1.4 RELATED SECTIONS

A. Section 230500 – General HVAC Requirements

B. Section 230513 – Common Motor Requirements for HVAC Equipment

C. Section 230900 - Instrumentation and Control for HVAC

D. Section 233100 – HVAC Ducts and Casings

E. Section 233423 – HVAC Power Ventilators

1.5 SUBMITTALS

A. Submit manufacturer's product data sheets and start-up performance documentation for all materials and products.

B. Submit general arrangement and fabrication drawings which coordinate dampers with equipment, ducts, accessories, and existing conditions.

C. Submit shop drawings of supplemental vertical and horizontal bracing of multi-section dampers.

1.6 QUALITY ASSURANCE

A. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511 (VCD-20).

B. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance Air Leakage in accordance with AMCA 511.

1.7 DELIVIERY AND STORAGE

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.

C. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, accessory materials shall conform to the following:

1. Sheet and Strip Material	ASTM Specification
Galvanized steel, coating G90	A-527

B. Dampers shall be constructed in accordance with SMACNA HVAC Duct Construction Standards (latest edition) for differential pressures to 8" water column.

C. Stiffeners, reinforcing, bracing, supports, tie rods, rivets, screws, bolts, nuts and accessories used in direct contact with damper shall be of materials identical to the damper unless indicated otherwise.

2.2 VOLUME CONTROL DAMPERS WITH ELECTRIC ACTUATORS

A. Furnish low-leakage, control dampers as scheduled on the drawings and as follows:

1. Maximum Pressure Differential Rating: 8" water column.
2. Maximum Velocity Range: no less than 2,500 feet/minute
3. Temperature Range: -40 F to 250 F
4. Leakage Rating: Class 1 at 4 to 8 inches water column.
5. Frame: 5" x 1" hat channel, 12 gauge, galvanized steel, reinforced corners
6. Blades: 20 gauge, galvanized steel, insulated airfoil type, center pivot
7. Jamb Seals: Flexible, stainless steel, compression type
8. Blade Seals: Silicone
9. Axles: Square, positively locked into damper blade, plated steel

10. Axle Bearings: Corrosion resistant, permanently lubricated, 316 stainless steel

11. Linkage: Plated steel, blade-to-blade, out of air stream, concealed in jamb

12. Finish: Mill

13. Accessories: As indicated on damper schedule.

    a. Damper Guard: Galvanized, ½" welded wire or expanded mesh personnel protection screen.

    b. Weather Hood: Galvanized, with ½" welded wire bird screen, with mounting flange with pre-punched bolt holes.
        1) Intake: 90 degree.
        2) Exhaust: 45 degree.

    c. Damper Blade Position Switches: Spring rod type limit switch, single pole double throw, UL listed, 15 Amps at 125, 250, 480 VAC, 0.50 Amps at 125 VDC, 0.25 Amps at 250 VDC, 67°F to 185°F operating temperature, with damper frame mounting bracket and hardware.

        1) Mechanically monitoring blade farthest from damper actuator on multiblade dampers.

14. Actuators:

    a. As indicated on damper schedule and specified below.

    b. With mounting hardware, linkages, and jackshafts.

    c. Sized for damper break-away and operating torque requirements with sufficient reserve power to provide smooth action and proper speed of response at worst cast damper conditions.

B. Manufacturers: Subject to compliance with requirements, provide from one of the following:

1. Greenheck

2. Ruskin Mfg. Co.

3. Nailor

4. Or approved Equal

C. Multi-section dampers shall be provided with horizontal and vertical, galvanized steel, bracing to support damper weight and system pressure.

D. Multi-section dampers shall include multiple actuators and/or jackshafts as required so that all damper sections operate together.

2.3 TWO-POSITION ACTUATORS:

A. 120 volt, single phase, electric powered.

B. ISO 9001, cULus, CE, and CSA listed.

C. NEMA 4, UL Type 4 approved, IP 66 rated, suitable for outdoor installation, aluminum housing with plastic junction box.

D. Brushless motor technology, with microprocessor control, protected for overload at all angles of rotation, 75 second run time (max.)

E. -22 to 122 F temperature range, 95% relative humidity, non-condensing.

F. Fail-safe operation, with continuously engaged mechanical spring return that returns to damper fail-safe position within 10 seconds of power loss at -4 F to 122 F and within 15 seconds at -22 F to -4 F.

1. Fail Safe Position as scheduled on drawings.

G. Built-in limit end stop to match available damper rotation.

H. Manual override with locking function.

I. External position indicator.

J. Two Auxiliary End switches set at 10º and 85º for position indication and equipment interlocks, SPDT, 3A resistive maximum load at 250Vac.

K. Linkage – corrosion-resistant, provide members as required.

L. 5 year warranty.

M. Belimo EFCX or approved equal by Honeywell or Siemens.

2.4 MODULATING ACTUATORS:

A. 24 VAC/DC, electric powered.

B. Proportional control in response to a 2 to 10 VDC control signal.

C. ISO 9001, cULus, CE, and CSA listed.

D. NEMA 4, UL Type 4 approved, IP 66 rated, aluminum housing with plastic junction box.

E. Brushless motor technology, with microprocessor control, internal feedback, protected for overload at all angles of rotation, 95 second run time (max.)

F. -22 to 122 F temperature range, 95% relative humidity, non-condensing.

G. Fail-safe operation, with continuously engaged mechanical spring return that returns to damper fail-safe position within 20 seconds of power loss at -4 F to 122 F and within 60 seconds at -22 F to -4 F.

1. Fail Safe Position as scheduled on drawings.

H. Built-in limit end stop to match available damper rotation.

I. Manual override with locking function.

J. External position indicator.

K. Two Auxiliary End switches set at 10° and 85° for position indication and equipment interlocks, SPDT, 3A resistive maximum load at 250Vac.

L. Linkage – corrosion-resistant, provide members as required.

M. 2 to 10 VDC position feedback signal.

N. 5 year warranty.

O. Belimo EF Series or approved equal by Honeywell or Siemens.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive dampers.

B. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.

C. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install dampers in accordance with manufacturer's UL Installation Instructions.

B. Any damper installation aspect that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.

C. Dampers must be accessible to allow inspection, adjustment, and replacement of components.

D. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access.

E. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

F. Install dampers square and free from racking.

G. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

H. Do not compress or stretch the damper frame into the duct or opening.

I. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions for reinforcement between assemblies as required.

J. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

K. Coordinate actuators and positions switches with control and electrical work.

3.3 HANGERS AND SUPPORTS

A. Supports for dampers shall be installed in a manner that will not result in or produce excessive stress, deflection, swaying, sagging or vibration in the accessory, ductwork, or in the building structure either during erection, cleaning, testing or normal operation of the system.

B. Provide seismic restraints in accordance with the International Building Code (current edition) and SMACNA.

C. Dampers shall not be so restrained as to cause it to snake or buckle between supports or anchors or to prevent movement due to expansion and contraction.

D. Dampers shall be installed such that dampers can be disconnected and removed without further supporting the ductwork.

E. Ductwork shall not introduce any strains or distortions to the connected dampers.

F. Hangers and supports shall be installed complete, including lock nuts, rods, bolts, couplings, swivels, inserts, secondary steel and required accessory items.

G. All bolts, nuts, washers, screws, and other fasteners shall be cadmium plated, stainless steel or otherwise corrosion resistant.

3.4 JOINTS

A. Joints shall be sealed air-tight by means of gaskets, liquid sealant, sealing tape, or welding.

3.5 CONTROL DAMPERS WITH ELECTRIC ACTUATORS

A. Install dampers and actuators in accordance with manufacturer’s instructions.

B. Install horizontal and vertical bracing on multi-section dampers to support damper weight, wind loads, and system pressure.

3.6 START-UP AND TESTING:

1. Check out dampers and actuators in accordance with manufacturer’s Installation, Operating & Maintenance manual, prior to energizing.
2. Verify and document dampers operate in accordance with Sequence of Operations in presence of Owner’s Representative and provide written documentation.

END OF SECTION 233313.33

SECTION 233423 – HVAC POWER VENTILATORS

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 HVAC power ventilators.

1.3 RELATED SECTIONS

A. Section 230500 – General HVAC Requirements

B. Section 230513 – Common Motor Requirements for HVAC Equipment

C. Section 230900 - Instrumentation and Control for HVAC

D. Section 233313.33 – Volume-Control Dampers

1.4 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on 900 feet above sea level.

B. Operating Limits: Classify according to AMCA 99.

1.5 REFERENCES

A. All materials and workmanship described herein shall be in accordance with the latest editions and addenda of the applicable codes and standards written by the organizations listed below and all Federal, State, and local codes. Should there be any conflict between any code, standard, or specification, the more stringent shall govern.

B. AFBMA - Anti-Friction Bearing Manufacturer's Association

C. AISC – American Institute of Steel Construction

D. AMCA – Air Movement and Control Association

E. ANSI - American National Standards Institute

F. ASCE – Minimum Design Loads for Buildings and Other Structures

G. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers

H. ASME - American Society of Mechanical Engineers

I. ASTM - American Society for Testing and Materials

J. AWS - American Welding Society

K. IBC – International Building Code

L. IMC - International Mechanical Code

M. NEC - National Electrical Code

N. NEMA - National Electrical Manufacturers Association

O. NFPA – National Fire Protection Association

P. OSHA – Occupational Safety and Health Administration

Q. UL – Underwriters Laboratories

1.6 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show fan installation and relationships between components and adjacent structural and mechanical elements. Show transition ducts, support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. ACMA Certifications.

E. Field quality-control test reports.

F. Operation and Maintenance Data: Include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. Performance ratings:

1. Conform to AMCA standard 211 and 311.
2. Test in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory.
3. Fans shall be certified to bear the AMCA label for air performance seal

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. ASHRAE/IES Standard 90.1 compliant.

F. Seismic Rated to Design Category F per IBC and ASCE 7 with HCAI seismic certification.

1.8 WARRANTY

A. Equipment shall be warranted for a minimum period of 1 year from the date of substantial completion of the project in accordance with the General Conditions.

1.9 EXTRA MATERIALS

A. Provide one (1) complete set of spare fan belts for the belt driven fans.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Storage: Store materials in a dry area, indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual

C. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

D. Lift and support units with manufacturer's designated lifting or supporting points.

1.11 COORDINATION

A. Provide concrete housekeeping pads for base mounted equipment. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Barron
2. Chicago Blower Corporation
3. Cincinnati Fan
4. Clarage
5. Greenheck

6. Howden American Fan Co.
7. Loren Cook Company
8. New York Blower Company
9. Robinson
10. Twin City Fan & Blower

B. Description: Factory-packaged, shop-tested, heavy duty, industrial, direct drive, axial, propeller type, ventilating fan consisting of frame, wheel, motor, and accessories.

C. Arrangement: Side wall mounted, exhaust service.

D. Wheel: Propeller type, aluminum airfoil blades and hub construction, securely attached to fan shafts.

1. Statically and dynamically balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
2. Propeller and fan inlet shall be matched with precise running tolerances for maximum performance and operating efficiency.

E. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks and coated with an anti-corrosive coating.

1. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours L50 average life of 500,000 hours) at maximum cataloged operating speeds.
2. Drives shall be sized for a minimum of 150% of driven horsepower.
3. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to wheel and motor shafts. Motor sheaves shall be adjustable for system balancing.

F. Drive frame and panel assemblies shall be galvanized steel with manufacturer's corrosion resistant coating with long wall housing with protective guard.

1. Drive frames shall be formed channels and fan panels shall have prepunched mounting holes, formed flanges, and a deep formed inlet venturi.
2. Drive frames and panels shall be bolted construction or welded construction.

G. The axial exhaust or supply fans shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

H. Fans shall be statically and dynamically balanced and rated for continuous performance at speeds between 10% and 110% of design speed.

I. Motor Side Guard:

1. OSHA guard for personnel protection to completely enclose motor and drive side of fan.

J. Damper:

1. Damper: Fan inlet, control damper with electric actuator.
2. Comply with volume control damper specifications and damper schedule on the drawings.
3. Size: Coordinate with fan frame, housing, and air flow rate for proper fit.
4. Damper Guard: Expanded metal mesh, galvanized.

K. Weather Hood: Galvanized, 45 degree discharge, with ½" welded wire bird screen, bolted to fan housing.

L. Motors: Comply with requirements of Section 230513 – Common Motor Requirements for HVAC Equipment as applicable.

1. Electronically Commutated Motor
    a. Motor enclosure: Totally enclosed, fan cooled.
    b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications.
    c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
    d. Soft start
    e. Inherent internal thermal and current overload protection.
    f. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
    g. Factory mounted speed control transformer.
    h. Low voltage wiring harness for remote speed control signal.
    i. Motor shall be speed controllable down to 20% of full speed (80% turndown).
        1) Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC remote signal.
    j. Motor shall be a minimum of 85% efficient at all speeds
2. Non-overloading at any point on the fan curve at design speed.

M. Maximum catalogued continuous operating fan speed shall be no less than 10% above the fan speed required to achieve the specified design capacity and static pressure.

N. Capacities And Characteristics: As scheduled on the drawings.

1. Suitable for -10 F to 130 F continuous operating temperature.

2.2 FACTORY INSPECTIONS AND TESTING

A. Unit shall be fully assembled at the factory, inspected, tested, and determined to be in compliance with the Specifications. Any deviations found shall be corrected.

B. All the unit electrical devices shall be energized as components to insure operational integrity prior to unit shipment.

C. All fans shall have a dynamic balance performed after assembly.

1. The vibration velocity shall not exceed 0.1 inch per second vertically or horizontally at the bearing caps nor exceed 0.09 inch per second in the axial direction.
2. The exact level of vibration shall be recorded in the Operation and Maintenance Manual as proof of the dynamic balance at the factory.

D. Factory testing shall be done on the assembled unit.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fans level and plumb in accordance with manufacturer's instructions.

B. Coordinate base mounted fans with concrete housekeeping pad and anchor bolts.

C. Coordinate wall or roof mounted equipment with associated openings.

1. Provide transition ductwork as required.

D. Maintain manufacturer's minimum required distance between fan discharge and associated dampers for optimum performance.

E. Provide supports and braces for wall or roof mounted equipment.

F. Coordinate supports and connecting ductwork installation with fan frame/housing.

G. Install units with clearances for service and maintenance.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts/piping and electrical components are complete.
3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control dampers in connected ductwork systems are in fully open position.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.3 START-UP SERVICE

A. Provide a qualified, factory trained service engineer for the following:

1. Inspect and verify that equipment is properly installed and aligned.

2. Adjust, configure and calibrate controls, instruments, drives, dampers, actuators, lubrication, etc.

3. Supervise start-up.

4. Place fan system in regular satisfactory operating service.

5. Train Owner's personnel in operation and maintenance of equipment for two classes during the day shift on one day.

6. Provide any additional services required to maintain warranty and performance guarantees.

7. Detailed written records of the start-up performance shall be submitted to the Owner before the start-up engineer is released.

B. Contractor shall provide operators and trade labor during start-up.

1. Operating personnel provided by Contractor before equipment acceptance will work under the direction of service engineer(s).

2. Equipment operation prior to acceptance by Owner shall remain the complete responsibility of Contractor.

3.4 TESTING, ADJUSTING, AND BALANCING

A. Coordinate with Owner’s Representative.

B. Complete testing, adjusting, and balancing in presence of Owner’s Representative.

C. Prepare test reports for fan. Obtain manufacturer's recommended testing procedures.

D. Measure total air flow and inlet and outlet static pressures at design fan speed.

E. Adjust dampers to deliver total indicated airflow at design fan speed listed by fan manufacturer.

1. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed.
2. Do not make fan-speed adjustments that result in motor overload.
3. Consult equipment manufacturers about fan-speed safety factors.
4. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur.

F. Check fan operates properly across full range of fan speeds without vibration, stalling, surging, overheating, etc.

END OF SECTION 233423

SECTION 235750 – REMOTE RADIATOR – DIESEL ENGINE DRIVEN GENERATOR

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 SCOPE

A. The Contractor shall provide an outdoor remote radiator for an existing diesel-engine-driven emergency generator, along with all appurtenances, as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 230501 – General Mechanical Requirements for HVAC

B. Section 230513 - Common Motor Requirements for HVAC Equipment

C. Section 232000 – Piping for HVAC

1.4 SECTION INCLUDES

A. The work covered under this section shall include, but not be limited to, the following items:

1. Remote radiator
2. On site startup and testing
3. On site Owner training

1.5 SUBMITTALS

A. Submit shop drawings and product data.

B. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

a. Certified fan performance curves with system operating conditions indicated.

b. Certified fan sound-power ratings.

c. Motor ratings and electrical characteristics, plus motor and electrical accessories.

d. Material of construction, thickness, and finishes, including color charts.

C. Shop drawings shall include, but not be limited to, the following:

1. Detail equipment assemblies indicating materials of construction, dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Factory published specification sheet indicating standard and optional accessories, ratings, etc.

3. Technical data sheet(s) identifying the make and model including relevant component design and performance data.

4. Breakdown of all components and options to be included.

5. Product data showing dimensions, weights, ratings, interconnection points, and wiring diagrams, control panel schematics.

6. Manufacturer's catalog cut sheets of all auxiliary components.

7. Dimension drawings (plans and elevations) showing overall measurements, mounting locations, and interconnect point for structural, mechanical, electrical connections.

8. Seismic and wind design certifications.

9. SEDD tank sizing calculations.

10. Manufacturer's written warranty disclosure statement for the period specified.

D. Factory quality-control test reports.

E. Field quality-control test reports.

F. Operation & Maintenance Manuals:

1. Provide O&M Manuals that describe installation, operation, and maintenance of the equipment furnished complete with all wiring and schematic diagrams within two weeks after the unit ships from the factory.

2. Manuals shall be conformed to "as-built" status by incorporating any and all changes made during the start-up period.

1.6 REFERENCES

A. The equipment covered by this section of the Specifications shall be designed, assembled and tested in accordance with the latest applicable codes, regulations, and standards, including, but not limited to:

1. The International Codes (I-Codes), developed by the International Code Council

2. AFBMA - Anti-Friction Bearing Manufacturer's Association

3. AISC – American Institute of Steel Construction

4. AMCA – Air Movement and Control Association

5. ANSI - American National Standards Institute

6. ANSI/NEMA MG 1 – Motors and Generators

7. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

8. ANSI/NFPA 70 – National Electrical Code

9. ASCE – Minimum Design Loads for Buildings and Other Structures

10. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers

11. ASME - American Society of Mechanical Engineers
12. ASTM - American Society for Testing and Materials
13. AWS - American Welding Society
14. IEEE 3005 – Emergency and Standby Power Systems
15. IEEE 3006 – Power System Reliability
16. NEC - National Electrical Code
17. NEMA - National Electrical Manufacturers Association
18. NEMA 250 – Enclosures for Electrical Equipment (1000V Maximum)
19. NFPA – National Fire Protection Association
20. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines
21. NFPA 101 – Life Safety Code
22. NFPA 110 – Emergency and Standby Power Systems
23. OSHA – Occupational Safety and Health Administration
24. UL – Underwriters Laboratories

B. *Noise Emission:* Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the equipment, its components and the operation thereof.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver to project site and store and protect products at the project site in accordance with manufacturer's recommendations.

B. Accept equipment and accessories on site and document any and all damage upon receipt at the project site.

C. Protect equipment from dirt and moisture.

1.8 PROJECT RECORD DOCUMENTS

A. Submit record documents.

B. Accurately record location of equipment and mechanical and electrical connections.

1.9 QUALIFICATIONS

A. *Manufacturer:* Company specializing in packaged engine-generator remote radiator systems with minimum fifteen (15) years documented experience.

B. To qualify as a manufacturer, the complete equipment package must be a principal item manufactured by that manufacturer.

1.10 WARRANTY

A. Equipment shall be warranted for a minimum period of 1 year from the date of substantial completion of the project in accordance with the General Conditions.

1.11 EXTRA MATERIALS

A. Provide three (3) complete set of spare fan belts for the remote radiator.

1.12 FACTORY TESTS

A. The equipment manufacturer shall perform functional tests before shipping from the factory.

B. The test shall check equipment operation, performance, vibration, temperatures, leaks, safety devices, etc.

C. Test runs shall be made over the full design load range.

D. Any defects that become evident during these tests shall be corrected before shipping.

E. Test reports shall be included with the shipment of the equipment to the project site and with O&M Manuals.

F. If the above testing is not available at the factory, the manufacturer's authorized service representative shall perform the tests and provide a test report as part of the start-up services.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Remote radiator shall be furnished by Caterpillar or Caterpillar certified manufacturer's representative as required to properly function with existing Caterpillar diesel engine emergency generator.

B. Subject to compliance with all requirements specified herein and on the drawings, provide products by one of the following:

1. API Heat Transfer
2. Cincinnati Radiator
3. DRC Heat Transfer (formerly Diesel Radiator Company)
4. IEA Radiator Company
5. Young Touchstone
6. Or approved equal

2.2 EXISTING EMERGENCY GENERATOR AND REMOTE RADIATOR INFORMATION

A. Available information on the existing equipment is summarized below.

B. Existing Emergency Generator:

1. 1985 vintage Caterpillar 3516 Diesel Engine Generator Set
2. 1450 ekW Standby Rating

C. Existing Remote Radiator:

1. 1985 vintage Modine KK3-20.
2. +/- 6.5’ x 6.5’ air flow face area.
3. Vertical face, horizontal air flow.
4. 7 psig pressure cap original, 10 psig current.
5. Radiator appears to be undersized based upon operating issues and recent testing.

2.3 EXISTING DIESEL ENGINE EMERGENCY GENERATOR COORDINATION

A. Diesel engine remote radiator shall be a closed loop, air cooled, radiator, which is fully coordinated and operational with existing diesel engine-generator.

B. Caterpillar or Caterpillar certified manufacturer’s representative shall supply radiator and shall be responsible for this coordination, which shall include, but not be limited to, the following:

1. Confirm radiator cooling requirements with engine manufacturer.
2. Confirm cooling system pressure loss, including radiator loss, is compatible with existing engine-driven coolant pump.
3. Confirm radiator-mounted expansion tank and coolant system pressures are compatible with existing diesel engine coolant system pressure ratings and volumes and new coolant piping system.
4. Confirm radiator vent connections are compatible with existing engine coolant vent requirements.
5. Advise Engineer in writing of any issues.

2.4 GENERAL

A. The packaged diesel-engine-generator remote radiator shall be a coordinated assembly of compatible components.

B. All equipment and materials shall be new, and where applicable, shall bear the Underwriters’ Laboratories, Inc. (U.L.) Label of Approval.

C. Safety Standard: Comply with ASME B15.1.

D. Design parameters:

1. Site elevation ..... 880 ft.
2. Site Design air temperature range..... -20°F to 110°F
3. Remote Radiator Location ..... Outdoors
4. Solar Exposure..... Direct Sun Light
5. Performance Requirements..... As scheduled on the Drawings

6. Noise. ..... Maximum 90 dBA at 25 feet free field

E. Design Loads:

1. The radiator, as well as the means of fastening to the concrete foundation, shall be capable of withstanding gravity, wind, snow, ice, rain, and seismic loads.

2. The International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures (current editions) shall be used as the design basis with specific environmental factors as stated below.

3. Comply with the ASCE Design Hazards Report for the site included in Attachment 1 to Section 230501 – General Mechanical Requirements for HVAC.

4. Minimum Design Wind Speed: 120 mile per hour

5. Earthquake Design Data:

a. Occupancy Classification:

1) Power Plant: Moderate-hazard factory industrial, Group F-1

2) Correctional Center: Institutional Group I-3, Condition 5

b. Risk Category: IV

c. Seismic Importance Factor: Ie = 1.5

d. Site Class: D

e. Mapped Spectral Response Accelerations: $S_s = 0.23$, $S_1 = 0.1$

f. Spectral Response Coefficients: $S_{DS} = 0.2$, $S_{D1} = 0.14$

g. Seismic Design Category: D

h. Component Amplification Factor: $A_p = 2.5$

i. Component Response Modification Factor: $R_p = 2$

j. Overstrength Factor: $\Omega_o = 2$

k. Analysis Procedure: Equivalent Lateral Force ASCE 7

F. The equipment shall be mounted on a rigid structural steel base which shall provide adequate strength and rigidity to maintain alignment of mounted components.

G. Equipment shall be free from sharp edges and corners.

H. Include lifting attachments arranged for lifting with slings without damaging components.

I. *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.

2.5 DIESEL ENGINE REMOTE RADIATOR

A. Radiator shall be factory-packaged, shop-tested, heavy duty, industrial, liquid-to-air heat exchanger with integral fan, shaft, bearings, motor, v-belt drive assembly, top-mounted secondary expansion deaeration and drawdown tank (SEDD), and support structure.

B. Radiator shall be specifically designed for emergency generator service.

C. Radiator shall be sized to maintain safe engine temperature at full rated load in a maximum ambient temperature of 122°F based on 50/50 extended life ethylene glycol coolant/water mixture

1. *Coolant:* Caterpillar-approved solution of 50 percent Extended Life Ethylene Glycol Coolant (ELC) and 50 percent demineralized water, with anti-corrosion additives.

   a. The ELC provided shall meet or exceed the following specifications and guidelines: ASTM D-3306, TMC TP-329, ASTM D-6210, TMC RP-338 and SAE J1034.

2. *Fouling Allowance:* Radiator shall be sized for 115% of the scheduled cooling capacity to allow for fouling.

D. Design Pressure and Temperatures:

1. Radiator shall have a working pressure rating of no less than 25 psig at -40 F to 250 F.

2. Working pressure rating shall be included on equipment nameplate.

E. Frame and Support Structure:

1. Heavy duty, tamperproof, assembly framed with steel channels, angles, and braces designed for seismic, wind, and dynamic loads with minimal vibration.

2. Wide flange beams: ASTM A992 (50 ksi minimum yield stress).

3. Miscellaneous structural steel, plates, etc.: ASTM A36 (36 ksi minimum yield stress).

4. Structural tubing: ASTM A500, Grade B (46 ksi minimum yield stress).

5. Grilles: Heavy duty, carbon steel, expanded metal or wired mesh with bolt-on support framing at both air intake and exhaust for personnel and wild-life protection.

6. Corrosion Resistant Coating: Hot-dipped-galvanized in accordance with ASTM A123, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

7. Bolting Hardware: High strength, medium carbon alloy steel, SAE J429 Grade 8 bolts, nuts, and washers with rust-resistant, ASTM B633 yellow zinc dichromate finish.

8. Anchoring: Provisions for shimming, grouting, and anchoring to concrete with minimum 5/8” anchor bolts.

9. Lifting lugs.

F. Core:

1. Corrosion resistant, nonferrous-metal construction.

2. Designed to minimize fouling in dusty, farmland and industrial environments.

3. Heavy-wall brass tubing, seamless or electric-resistance welded, annealed, minimum 0.012” wall.

4. Straight, plain, non-louvered, non-offset, flat copper plate fins, brazed to brass tubes, with hemmed inlet and outlet edges, minimum 0.003” thickness.

a. Large, continuous, straight air flow channels

b. Maximum eight fins per inch.

5. Minimum half-inch thick, carbon steel, top and bottom header plates with machined O-ring top and bottom tank seals.

6. Mechanically bonded, roller-expanded tube-to-header joints.

7. Flanged, carbon steel, top and bottom tanks with O-ring seals, minimum 7 gauge (0.18”), powder coated.

8. Corrosion-resistant, baked phenol epoxy, Heresite P-413 coating, with 400 F continuous temperature resistance.

G. Vents and Drains:

1. Radiator shall be completely self-draining and self-venting, with accessible, capped drain and vent/fill connections at the lowest and highest points on the radiator.

H. Fan and Shroud:

1. Blower type fan with galvanized carbon steel, deep plenum fan shroud box with close fit fan rings.

2. Maximum continuous operating fan speed shall be no less than 10% above the fan speed required to achieve the design capacity and static pressure.

3. Fans shall be statically and dynamically balanced and rated for continuous operation at speeds between 10% and 110% of design speed.

4. Wheel: Propeller type, cast aluminum, airfoil fan blades and hub construction securely attached to fan shaft.

a. Statically and dynamically balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.

b. Propeller and fan shroud shall be matched with precise running tolerances for maximum performance and operating efficiency.

c. Rotor stresses due to centrifugal forces shall not exceed 70% of the material yield strength at maximum operating temperature.

5. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

b. Designed to operate at no more than 80 percent of first critical speed at top of fan's speed range.

6. Grease-Lubricated Shaft Bearings: Heavy duty, self-aligning, sealed, outdoor-rated, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing on rigid steel base.

a. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours at maximum catalogued operating speed and horsepower.

b. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours at maximum catalogued operating speed and horsepower.

7. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

a. Service Factor Based on Fan Motor Size: Minimum 1.3.

b. Fan Pulleys: Precision machined cast iron or cast steel, keyed and securely attached to shafts; dynamically balanced at factory.

c. Motor Pulleys: Fixed pitch.

d. Belts: Oil and heat resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

e. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements.

1) Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2) Painted safety yellow.

f. Motor Mount: Adjustable for belt tensioning.

I. Motor:

1. Comply with requirements of Section 230513 – Common Motor Requirements for HVAC Equipment as applicable.

2. Motor enclosure: Totally enclosed, fan cooled (TEFC).

3. Permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.

4. Motor shall be a minimum of 85% efficient at all speeds

5. Non-overloading at any point on the fan curve at design speed

J. Secondary Expansion Deaeration And Drawdown Tank:

1. Integral, top-mounted, powder coated, carbon steel, secondary expansion deaeration and drawdown tank (SEDD), minimum 0.188” wall thickness.

2. Sized for coolant liquid-gas deaeration, separation, and venting, coolant expansion without coolant release, and coolant system operating pressures compatible with diesel engine.

3. SEDD tank size shall be determined by Caterpillar or Caterpillar certified manufacturer’s representative and radiator manufacturer based upon engine, radiator, and piping system coolant volumes and temperatures.

a. Existing engine coolant volume = +-/ 70 gallons

b. New coolant piping volume = +/- 200 gallons

c. Existing engine and new piping coolant volumes shall be field verified.

4. SEDD tank shall be sized for no less than 25% of the total coolant system volume, unless approved otherwise by Engineer.

a. 10% coolant drawdown volume.

b. 6% coolant thermal expansion volume.

c. 9% coolant deaeration volume.

K. Accessories: The following radiator accessories shall be included.

1. Filler pressure cap with 15 psig pressure relief valve and vacuum valve.

a. Pressure relief setpoint shall be confirmed with engine manufacturer's coolant system pressure and temperature requirements.

2. Fill neck with vent hole.

3. Coolant low level switch connection – minimum 1" FNPT.

4. Coolant low level switch.

5. Coolant visual level gauge connections – minimum 1" FNPT.

6. Coolant visual level gauge.

7. Radiator core vent tube.

8. Three (3) vent pipe connections above coolant level – minimum 1" FNPT with plugs.

9. Low point fill (draw down) pipe connection – minimum 1.5" FNPT with plug.

10. Coolant system drain – minimum 1" FNPT with plug.

11. Coolant Inlet and Outlet Connections: 6", Flanged, ANSI Class 150.

12. Piping shall comply with Section 232000 specifications for coolant supply and return piping (GLYCS/GLYCR).

2.6 FACTORY INSPECTIONS AND TESTING

A. Unit shall be fully assembled at the factory, inspected, tested, and determined to be in compliance with the Specifications. Any deviations found shall be corrected.

B. All the unit electrical devices shall be energized as components to insure operational integrity prior to unit shipment.

C. All fans shall have a dynamic balance performed after assembly.

1. The vibration velocity shall not exceed 0.1 inch per second vertically or horizontally at the bearing caps nor exceed 0.09 inch per second in the axial direction.

2. The exact level of vibration shall be recorded in the Operation and Maintenance Manual as proof of the dynamic balance at the factory.

D. Factory testing shall be done on the assembled unit.

2.7 MISCELLANEOUS

A. All moving parts shall have metal guards to prevent entanglement of falling objects and provide personnel protection.

B. All non-galvanized, cast iron and carbon steel materials shall be cleaned and coated the manufacturer's standard heat and chemical resistant coating.

1. Furnish one (1) quart of the touch-up paint.

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 and referenced standards.

B. Install radiator level and plumb in accordance with manufacturer’s instructions.

C. Install floor-mounting units on concrete bases.

D. Coordinate anchor bolt installation with fan base.

E. Install units with clearances for service and maintenance.

F. Install “shipped loose” items in accordance with the manufacturer’s written instructions and as indicated on the Drawings.

G. Provide field piping as required for a fully functional engine cooling system.

H. Provide conduit and wiring/cabling in accordance with the manufacturer’s written instructions and as indicated on the Drawings to connect the various components of the remote radiator and the emergency power system together to make a complete and functioning system.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts/piping and electrical components are complete.
3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Verify lubrication for bearings and other moving parts.

9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties.

C. Replace damaged and malfunctioning controls and equipment.

3.4 START-UP SERVICES

A. Field inspection and testing shall comply with manufacturer’s requirements and with NFPA 37 and 110 requirements.

B. The engine-generator manufacturer's authorized service representative shall fill the entire cooling system (radiator, jacket water, and intercooler) with properly mixed coolant consisting of 50% demineralized water and 50% extended life coolant including the manufacturer's recommended type and quantity of anti-corrosion additives.

1. All coolant shall be thoroughly mixed BEFORE placing into the cooling system radiator at the factory or job site when the radiator ships loose.

2. Coolant shall be placed into the cooling system through the fill cap opening of the radiator.

C. Prior to any testing, and before starting the radiator, the engine-generator manufacturer's authorized service representative shall perform the following:

1. Coolant shall be checked for conformity to the manufacturer's recommendations under the environmental conditions present and expected.

2. Tests shall be made to check for leaks, cooling air flow, movement during starting and stopping, vibration during running.

D. The equipment manufacturer shall provide the services of factory authorized field technician(s) for the following:

1. Verify that all equipment is installed properly

2. Check all auxiliary devices for proper operation

3. Test all alarms and safety shutdown devices for proper operation and annunciation

4. Check all fluid levels

5. Start equipment and check for proper operation, leaks, vibrations, etc.

6. Measure and report the following across the full range of engine generator loads in 10% load increments.

a. Radiator air flow rate, inlet temperature, outlet temperature, inlet pressure, outlet pressure.

b. Radiator coolant flow rate, inlet temperature, outlet temperatures, inlet pressure, outlet pressures.

c. Radiator motor voltage, current, power factor, kilowatts.

d. Coolant strainer inlet and outlet pressures.

e. Engine coolant pump suction pressure.

f. Radiator motor voltage, current, power factor, kilowatts.

3.5 ADJUSTING

A. Adjust equipment and controls in accordance with manufacturer’s requirements.

3.6 CLEANING

A. Clean equipment surfaces.

3.7 DEMONSTRATION

A. Provide systems demonstration.

1. Demonstrate that remote radiator system operates properly.
2. Demonstrate that remote radiator provides adequate cooling to allow diesel emergency generator to operate properly at full rated load.
3. Demonstrate that radiator system interfaces properly with associated emergency diesel engine generator control system.

B. Coordinate the demonstration schedule with the Construction Representative and the Engineer.

3.8 TRAINING

A. Provide four (4) hours of on-site training by factory trained field service engineer to instruct the Owner's personnel in the proper operation and routine maintenance of the equipment.

B. Review operation and maintenance manuals, parts manuals and emergency service procedures.

C. This shall be done after completion of the acceptance testing in two sessions, one in a.m. and one in p.m.

END OF SECTION 235750

SECTION 260115 – PREVENTATIVE MAINTENANCE FOR 4.16 kV METAL-ENCLOSED SWITCHGEAR

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 SCOPE

A. The Contractor shall provide the equipment manufacturers recommended preventative maintenance for the 4.16 kV utility metering switchgear located outside the Power Plant at the Ameren Missouri substation and the 4.16kV main switchgear located inside the Power Plant in accordance with the equipment manufacturers instruction manuals and industry standards.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

1.4 COORDINATION

A. It is the intent of the specified herein shall be coordinated with all other Division 26 work in order to reduce the number and duration of power outages to the facility to the greatest extent possible.

B. Execute the work specified herein to occur during the facility power outage required to tie-in the new 4.16 kV automatic transfer switch to the existing 4.16 kV main switchgear.

C. Provide an adequate number of field service personnel in order to complete the work specified herein in a single 8-hour power outage on a Tuesday, Wednesday or Thursday, that is not a State of Missouri observed holiday, between the hours of 8 am and 4 pm. Schedule this work far enough in advance to ensure an adequate number of field service technicians are available.

D. Confirm date and time that work is to be performed with the Construction Representative a minimum of four (4) weeks in advance and obtain Owner's approval before proceeding.

1.5 SUBMITTALS

A. Qualification data for preventative maintenance services provider organization.

B. Qualification data, including training certification data, for all field services technicians certifying adequate training and experience for the specific type of equipment involved on this project.

C. List of test equipment to be used in the performance of the preventative maintenance services, including manufacturer and model number for each item.

D. Submit calibration certificate for each piece of test equipment, including torque wrenches, to be used in the performance of the preventative maintenance services.

E. Submit copies of standard forms used for testing and recording field data for the 4.16 kV switchgear, load-interrupter switches and 4.16 kV utility metering switchgear.

F. Submit report indicating all test results and identifying all problem areas and recommendations for remedial action.

1.6 APPLICABLE STANDARDS

A. The work specified herein shall be governed by the latest applicable ANSI, NEMA and NFPA standards, including but not limited to:

1.	ANSI/IEEE	C2	National Electrical Safety Code
2.	ANSI/IEEE	C37.20.3	IEEE Standard for Metal-Enclosed Interrupter Switchgear Rated above 1kV AC up to and Including 48.3 kV AC
3.	ANSI/IEEE	C37.20.4	IEEE Standard for Indoor AC Switches (1 kV to 38 kV) for Use in Metal-Enclosed Switchgear
4.	ANSI/IEEE	C37.20.7	IEEE Recommended Practice for Testing Switchgear Rated Up to 52kV for Internal Arcing Faults
5.	ANSI/IEEE	C37.22	Preferred Ratings and Related Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear
6.	ANSI	C37.57	Switchgear - Metal-Enclosed Interrupter Switchgear Assemblies - Conformance Testing
7.	ANSI	C37.58	Switchgear - Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear - Conformance Test Procedures
8.	ANSI/IEEE	C39.1	Requirements for Electrical Analog Indicating Instruments
9.	ANSI/IEEE	C57.13	IEEE Standard Requirements for Instrument Transformers
10.	ANSI/NETA	MTS	Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems
11.	NEMA CC1		Electrical Power Connectors for Substations
12.	NEMA SG-2		High Voltage Fuses
13.	NEMA SG-5		Power Switchgear Assemblies
14.	NFPA 70		National Electrical Code
15.	NFPA 70B		Recommended Practice for Electrical Equipment Maintenance
16.	NFPA 70E		Standard for Electrical Safety in the Workplace
17.	OSHA 29 CFR 1910 - S		Occupational Safety and Health Standards – Subpart S – Electrical

1.7 NECESSARY EQUIPMENT FOR 4.16 kV METAL-ENCLOSED SWITCHGEAR SERVICE

A. Provide the following items as applicable for performance of the preventative maintenance services specified herein:

1. Personnel protective equipment in accordance with NFPA 70E
2. Project folder/notebook for documentation of test results and findings
3. Standard medium-voltage switchgear accessories and maintenance tools
4. Insulation resistance test set – 1000 VDC minimum
5. Low resistance digital ohmmeter – 10-amp minimum
6. Specimen grounding jumpers and ground mats
7. Torque wrenches, pound-inches and pound-feet
8. Phase rotation meter
9. RMS digital multimeter
10. Phase angle meter
11. Secondary injection test set
12. AC/DC power supply
13. Variable current source
14. Current transformer test set
15. AC HiPotentional test set – 60 Hz
16. Shopvac
17. Lock-out/Tag-out

1.8 ACCEPTABLE PROVIDERS

A. The preventative maintenance services for 4.16 kV metal-enclosed switchgear, load-interrupter switches and associated equipment and accessories shall be provided by one of the following:

1. ABB
   Kansas City, KS
   (913) 286-8028
   Roger Andrews
2. Eaton Engineering Services and Systems
   62 Soccer Park Rd.
   Fenton, MO 63026
   (636) 734-2316
   Kyle Crangle
3. Electric Power Systems
   21 Millpark Ct.
   Maryland Heights, MO 63043
   (314) 807-2682
   Shawn Allen
4. Schneider Electric Services

St. Louis, MO
(314) 437-6987
Andrea Wolfe

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ACTIVITIES PRIOR TO PREVENTATIVE MAINTENANCE SERVICE AND TESTING

A. Procure and Review:

1. Equipment drawings, schematics and wiring diagrams associated with equipment/device being tested (Owner has very limited information on file)
2. Instruction bulletins/books (Owner does not have these)
3. Protective device coordination study and arc flash risk assessment provided under Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment
4. Test data and field service forms
5. Safe working procedures and MSDS forms that apply to the equipment/device being tested
6. Site safety rules and emergency procedures
7. Site electrical one-line diagrams (Project Drawings ED-601, ED-602, E-601 & E-602)

B. Preparation and Safety (NOTE: The following recommendations are not intended to take precedence over the Contractor's safety procedures or industry standards. The Contractor shall be responsible for the safety of all personnel on-site and for any damage to Owner's equipment caused by Contractor's action, inaction, willful act and/or negligence.)

1. Perform any and all required switching of existing 4.16 kV load-interrupter switches in existing switchgear as necessary to isolate the 4.16 kV metal-enclosed switchgear to be serviced. Contractor shall be responsible for the switching of all equipment.
2. Open the site emergency generator 4.16kV output circuit breaker located next to the generator inside the Power House.
3. Apply lock-out/tag-out to all open switches and circuit breakers.
4. Contact Ameren Missouri for disconnection of the incoming utility feeder to the outdoor 4.16 kV metal-enclosed utility metering switchgear and apply safety grounds on the line side bus of the switchgear. NOTE: Ameren Missouri may choose to apply their own safety grounds.

   Ameren Missouri Construction Services
   866-992-6619
   servicerequest@ameren.com

C. Verify:

1. The equipment nameplate ratings are consistent with the equipment drawings provided.

2. Suitability of tools and test equipment for use on the equipment to be tested.

3. Test data and field service forms are available with the following data to be recorded prior to the start of testing:

   a. Customer and project information

   b. Equipment designation from site one-line diagram and equipment schedules

   c. Serial number of equipment, if applicable

   d. Field data

   e. Equipment ratings, e.g., voltage, current, control voltage, short circuit current rating, interrupting rating, etc.

   f. As found conditions of equipment prior to the start of testing

   g. Temperature, humidity and general weather conditions at the time of testing

   h. Date and time of testing

   i. Test equipment data

   j. Field service technicians' names and company information

   k. As found conditions prior to testing

3.2 INSPECTION AND TEST PROCEDURES

A. As a minimum, perform the following inspection, testing and preventative maintenance activities for all equipment. Report serious deficiencies immediately to the responsible Owner's representative at the Facility.

1. Examine 4.16 kV metal-enclosed switchgear line-up including all load-interrupter switches and accessories for:

   a. Loose or obviously damaged components

   b. Proper identification

   c. Proper application of the load-interrupter switches and fuses

   d. Compliance with switchgear drawings

   e. Doors, panels, and sections for alignment, dents, scratches, fit and missing hardware

   f. Maintenance accessories for servicing and operating all devices

2. Inspect switchgear for:

   a. Inspect all grounding connections for cleanliness and alignment

   b. Main bonding jumper for proper size and termination per NEC 250

   c. Insulators for evidence of physical damage or contaminated surfaces

   d. Load-interrupter switches and fuse mountings for physical condition, cleanliness and lubrication

   e. Alignment and penetration of instrument transformer withdrawal disconnects, current carrying, and grounding components

   f. Control power transformers

g. Wiring for damaged insulation, broken leads, tightness of connections, proper crimping, and overall general condition

h. Structure, grounding, cables and bus assembly

i. Verify whether the switchgear has a neutral bus and if so, whether it is bonded to ground. (**Notify Designer regarding findings while field service technicians are on-site.**)

j. Verify the grounding electrode conductor is properly sized in accordance with NEC 250 and is properly terminated

k. Verify the proper grounding of instruments, panels, and connections per NEC 250

l. Verify that conductors are properly identified

m. Verify cable termination tightness to manufacturer's published values by calibrated torque wrench

n. Verify integrity of insulation on bus bars and cable to bus connection

o. Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published values

p. Verify correct barrier and shutter installation and operation

q. Verify that filters are in place and/or vents are clear from obstructions

r. Control and instrumentation:

1) Verify that all PT (VT) and CT ratios properly correspond to drawings and that polarity is correct

2) Verify that shorting screws and bars are removed from CT's and terminal blocks as required

3) Verify the primary and secondary fuse ratings match the switchgear drawings

4) Verify meter scaling and type match the switchgear drawings

5) Verify that accessible moving components are adequately lubricated per the equipment manufacturer's recommendations

s. Key Interlock Systems

1) Verify key number and exchange codes

2) Verify proper sequencing to comply with switchgear drawing notes

3) Attempt to close locked-open devices

4) Attempt to open locked-closed devices

5) Make key exchange with devices operated in off-normal positions

6) Disposition of duplicate keys found shall be per the Owner's safety policy

t. With each load-interrupter switch open, inspect:

1) Primary leads, insulators, and disconnects

2) Ground contact, secondary disconnect, close and trip interlocks, levering latch, and all other interlocks

u. Verify manual operation of each load-interrupter switch

1) With each load-interrupter switch closed:

i. Inspect contact wipe ("T" Slot)

ii. Measure contact resistance using a 10-amp minimum DC source and compare with previous results if information is available

iii. Open load-interrupter switch

2) With each load-interrupter switch open:

i. Perform the "OPEN" portion of AC high potential test

v. Perform control wiring AC high potential test at 1,125V RMS. Do not perform this test on wiring connected to solid state components.

w. Verify the proper operation of all interlocks:

1) Maintenance interlock

2) Levering interlock

3) Positive interlock

4) Negative interlock

5) Positive closing interlock

6) All other devices

B. As a minimum, provide the following electrical testing on the switchgear:

1. Insulation system:

a. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground. Values shall be in accordance with manufacturer's published data.

b. Perform insulation-resistance tests at 500 VDC on all control wiring. **Do not perform this test on wiring connected to solid-state components.**

2. Control and Instrumentation:

a. Perform the following tests on control power transformers:

1) Insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be as specified by the equipment manufacturer.

2) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary winding connected.

3) Perform secondary wiring integrity test. Confirm potential at all devices.

4) Verify correct function of control transfer relays located in switchgear.

5) Verify operation of switchgear anti-condensation space heaters.

b. Perform the following tests on potential transformers:

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be as specified by the equipment manufacturer.

2) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary winding connected.

3) Perform secondary wiring integrity test. Confirm potential at all devices.

c. Perform the following tests on current transformers:

1) Ratio

2) Saturation

3. Protection devices:

a. Verify all fuses are as indicated on the Project Drawings and record fuse size, type and manufacturer for fuses that do not match the Drawings or are not indicated on the Drawings.

b. Record conduit size and type and cable type, quantity and sizes, including equipment ground, for switchgear feeders that are shown on the Project Drawings as needing to be verified.

C. Perform the following after completion of testing.

1. Before re-energizing the equipment:

a. Remove metal shavings and thoroughly clean and vacuum the equipment. Use only cleaning products recommended by the equipment manufacturer. No petroleum- based cleaners of any kind shall be used.

b. Remove and account for all test equipment, jumper wires, and tools used during testing

c. Remove and account for all safety grounds and tools

d. Replace all barriers and covers, close all doors, and secure all latches. Do not use power actuated tools to install threaded fasteners to avoid cross threading or stripping of the threads from overtightening and ensure all fasteners are installed including all fasteners that were missing.

2. Ensure all test forms and field data sheets are properly completed with all data entered correctly. Note all corrective actions taken, deficiencies found and recommendations, as well as any general comments.

3. Apply a test sticker that includes name of testing firm date and initials of technician on each switchgear vertical section door.

4. Review and organize all test results into a report with cover that includes the project information and a table of contents.

END OF SECTION 260115

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

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 SCOPE

A. The requirements of this section are applicable to all work performed under Division 26 – Electrical.

1.3 RELATED SECTIONS

A. Division 03 – Concrete

1.4 DESIGN LOADS

A. Outdoor electrical systems, as well as the means of fastening to building structures and foundations, shall be capable of withstanding gravity, operating, wind, snow, ice, rain, and seismic loads.

B. Indoor electrical systems, as well as the means of fastening to building structures and foundations, shall be capable of withstanding gravity, operating, and seismic loads.

C. The latest editions of International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures shall be used as the design basis with specific environmental factors as stated below.

D. Comply with the ASCE Design Hazards Report for site included as Attachment 1 to this Section.

E. Minimum Design Wind Speed: 120 mile per hour

F. Earthquake Design Data:

1. Occupancy Classifications:
    a. Power Plant: Moderate-hazard factory industrial, Group F-1
    b. Correctional Center: Institutional Group I-3, Condition 5
2. Risk Category: IV
3. Seismic Importance Factor: Ie = 1.5
4. Site Class: D
5. Mapped Spectral Response Accelerations: Ss = 0.23, S1 = 0.1
6. Spectral Response Coefficients: SDS = 0.2, SD1 = 0.14
7. Seismic Design Category: D
8. Component Amplification Factor: Ap = 2.5

9. Component Response Modification Factor: Rp = 2

10. Overstrength Factor: Ωo = 2

11. Analysis Procedure: Equivalent Lateral Force ASCE 7

1.5 COORDINATION

A. It is the intent of the Electrical Division of these Specifications that all electrical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations shall operate as designed.

B. Provide a complete operational electrical system. Route conduit and install equipment to avoid conflicts with other trades and to enhance maintainability of system.

C. All construction work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

D. The Owner intends to make continued use of existing facilities. Utilities and services to existing facilities shall not be interrupted without the Owner's approval as to the time and duration. The Owner will continue to occupy the existing facilities throughout the construction operations, and the Contractor shall so organize his work as to cause a minimum of interference with the normal routine activities of the facilities. All interruptions shall be scheduled at the convenience of the Owner.

E. The Contractor shall coordinate his work so there shall be no prolonged interruptions of existing equipment and all interruptions of utilities must be scheduled with the Owner. In no case shall any utilities be left disconnected at the end of a work day or over the weekend.

F. Any interruptions of any utilities either intentionally or accidentally shall not relieve the Contractor responsible from repairing and restoring the utility to normal service. Repairs and restoration shall be made before the workmen responsible for the repair and restoration leave the job on the day such interruptions occur.

G. The Contractor's area for construction shall be as shown on the Drawings.

H. The Contractor shall maintain access to the Owner's facilities during construction by keeping clear the drives in the construction area. Any blockage of the drives shall be scheduled with the Owner.

I. This project will involve several contractors in addition to this Contractor. There may also be contractors not associated with this project working in the vicinity.

J. This Contractor shall cooperate fully with the other contractors in the conduct of the work. Such cooperation with regard to work schedules, area of work, etc., is to be a normal part of this type of project and no extra compensation will be allowed for it.

1.6 DEFINITIONS

A. Concealed: Where the word “concealed” is used in conjunction with raceways, equipment, and the like, the word shall be understood to mean hidden from sight as in chases, furred spaces, or above suspended ceilings.

B. Exposed: Where the word “exposed” is used, the word shall be understood to mean open to view.

C. Provide: Where the word "provide" is used, in the Specifications or on the Drawings, it shall mean "furnish and install" unless otherwise noted or specified.

D. Related Work: The sections referenced under RELATED SECTIONS shall be understood to include provisions which directly affect the work being specified in the section where RELATED SECTIONS occurs.

E. Temporary Generator: A Contractor furnished, trailer mounted diesel-engine-driven generator that is connected to provide power to a building or the site power distribution system when there will be an interruption of the normal power supply to a portion of the building, multiple buildings or the entire site that will exceed 8 hours. The size of this generator shall be as required based on the amount of electrical distribution equipment affected by the power outage. The minimum size temporary generator for a power outage affecting the Ameren Missouri utility supply to the 4.16kV maim switchgear in the Power House shall be 1000 kW during the period from October 15 to April 15 and 1250 kW during the period from April 16 to October 14.

F. Temporary Emergency Generator: A Contractor furnished, trailer mounted diesel-engine-driven generator that is connected to the 4.16kV main switchgear in the Power House via the new medium-voltage generator connection cabinet specified in Section 263290 – Medium-Voltage Generator Connection Cabinet to provide auto-start emergency generator backup for the facility during the time the facility's permanently installed emergency generator is out of service. The minimum size for the temporary emergency generator shall be 1000 kW during the period from October 15 to April 15 and 1250 kW during the period from April 16 to October 14.

G. The Work: Where the words "the Work" are used together, they shall be understood to mean the work under contract that is governed by these Specifications and the Drawings.

1.7 SUBMITTALS

A. The Contractor shall submit to the Designer for approval, prior to fabrication and in accordance with the procedures outlined in Section 013300 – Submittals, all submittals as required by each Section in this Division of these Specifications.

B. Each submittal shall be properly identified as to the specific equipment to which it relates. Identification on the submittal shall be by reference to equipment identification numbers as shown on the Drawings and, if applicable, by reference to the appropriate Article of the Specifications in which the equipment is specified.

C. Shop drawings, brochures, or manufacturer's product data sheets showing more than one size or model shall be marked to indicate the size or model proposed for the particular application.

D. All submittals shall be certified by the Contractor as being correct for the proposed work.

E. Submittals in the form of shop drawings shall include complete data on the equipment to be provided, including physical dimensions and other information required for installation, performance capabilities and limitations, and schedules indicating locations when more than one type of an item is to be used.

F. Prior to submittal, shop drawings shall be coordinated with the work of all other trades.

G. Any and all submittals that do not comply with all of the above requirements will be rejected and returned without review.

H. Provide installation, operation and maintenance manuals in accordance with Section 013300 – Submittals, Section 007213 – General Conditions and 007300 – Supplementary Conditions.

1.8 RECORD (AS-BUILT) DRAWINGS

A. The Contractor shall update a complete set of the construction drawings, shop drawings and schedules of all work daily 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 Owner's Representative in accordance with Section 007213 – General Conditions. 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 or structures. All concealed items both inside and outside shall be accurately located 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.

B. No deviations from the Contract Drawings or approved shop drawings shall be made without prior approval from the Designer or Owner's Representative.

1.9 REFERENCE STANDARDS

A. Included as a basic part of these Specifications are the applicable regulations of the standards listed below. Portions of all of certain recognized industry or association standards referred to herein as being a requirement of these Specifications shall be considered as binding as though reproduced in full herein. Unless otherwise stated, the reference standard shall be the latest edition of the standard which is current as of the date of issuance of the Contract Documents. Where conflicts exist from one code to another, the more stringent requirement shall apply.

B. Referenced Codes and Standards constitute minimum requirements and strict compliance is required therewith unless supplemented and/or modified by more stringent requirements in these Specifications.

C. Reference may be made to standards either by full name or by letter designation as follows:

1.	ACI	American Concrete Institute
2.	AHDGA	American Hot Dip Galvanizers Association, Inc.
3.	AISC	American Institute of Steel Construction
4.	ANSI	American National Standards Institute
5.	ASA	American Standards Association
6.	ASCE	American Society of Civil Engineers
7.	ASTM	American Society for Testing & Materials
8.	AWS	American Welding Society
9.	BOCA	Building Officials and Code Administrators International, Inc.
10.	CSA	Canadian Standards Association

11.	EEI	Edison Electric Institute
12.	EIA	Electronics Industries Association
13.	ETL	Electrical Testing Laboratories, Inc.
14.	FMRC	Factory Mutual Research Corp
15.	IACS	International Annealed Copper Standard
16.	IBC	International Building Code
17.	IBEW	International Brotherhood of Electrical Workers
18.	ICC	International Code Council
19.	ICEA	Insulated Cable Engineers Association
20.	IEC	International Electrotechnical Commission
21.	IEEE	Institute of Electrical and Electronics Engineer
22.	IFC	International Fire Code
23.	ISA	The Instrumentation, Systems, and Automation Society
24.	JIC	Joint Industrial Council
25.	NBFU	National Board of Fire Underwriters
26.	NEC	National Electrical Code (NFPA 70)
27.	NECA	National Electrical Contractors Association
28.	NEMA	National Electrical Manufacturers Association
29.	NESC	National Electrical Safety Code
30.	NETA	InterNational Electrical Testing Association
31.	NFPA	National Fire Protection Association
32.	NIST	National Institute of Standards and Technology (formerly National Bureau of Standards, NBS)
33.	OSHA	Occupational Safety and Health Administration
34.	UL	Underwriters' Laboratories, Inc.

1.10 REGULATORY LAWS, ORDINANCES, CODES AND STANDARDS

A. The governing federal, state, and local laws, codes and standards in effect at the project site constitute the minimum requirements for all electrical work, and strict compliance therewith is required unless supplemented and/or modified by more stringent requirements of the Contract Documents.

B. All work under this Contract shall be performed in full compliance with the 2023 edition of the National Electrical Code (NEC) NFPA-70 and the latest edition of the National Electrical Safety Code (ANSI C2).

C. The Contractor shall keep a copy of the 2023 NEC on the project site for his reference at all times.

D. Requirements in reference specifications and standards are a minimum for equipment, material, and work. In instances where capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified or scheduled capacities.

E. Resolve code interpretations discovered in Contract Documents with Designer prior to Contract award. After Contract award, make corrections or additions necessary for compliance with applicable codes.

1.11 CONTRACT DRAWINGS

A. Included under Section 000115 – List of Drawings of these Specifications are the Drawings which indicate in general the character, arrangement, and construction of equipment and materials called for in these Specifications.

B. Drawings are generally diagrammatic and are intended to encompass a system that will not interfere with the structural and architectural design of the building. Coordinate work to avoid interferences between conduit, equipment, architectural, and structural work.

C. Drawings are based on preliminary information provided by manufacturers of the equipment specified. Make adjustments, modifications, or changes required, based on shop drawings furnished by the manufacturer of the equipment to be furnished on this project.

1.12 WORKMANSHIP

A. All work shall be done under the supervision of the Contractor who shall provide competent foremen to lay out all work. All work shall be laid out with due regard for proper working clearances about electrical equipment in accordance with NEC Article 110 and the space requirements of other contractors. The Contractor shall immediately report to the Owner’s Representative any conflict or difficulties with regard to the installation.

B. The Contractor shall be completely responsible for all work installed by him and shall employ only competent and experienced personnel of proper trades to perform the work.

C. All work shall be installed so as to be accessible for operation, maintenance, adjustment, replacement, and repair with particular attention given to locating controls and other items requiring periodic lubrication, cleaning, adjusting, or servicing of any kind.

D. Local disconnect switches, control stations, conduit drops, control panels, electrical enclosures, instrumentation, etc. shall be located so as not to interfere with access required for the necessary service and operation of equipment and shall meet the working clearance requirements of Article 110 of the National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Only NEW, clean and perfect equipment, apparatus, materials, and supplies of latest design and manufacture shall be incorporated in the work in order to assure an electrical system of high quality.

B. All materials shall be new, shall be installed according to manufacturer's specifications or as directed by the Designer, and shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or other nationally recognized testing laboratory.

C. All materials and equipment furnished under these Specifications shall be standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of the specific items is required, all shall be of the same type and by the same manufacturer.

D. The product of a manufacturer shall be acceptable only when that product complies with or is modified as necessary to comply with all specified and indicated requirements in the Contract Documents.

E. Materials and equipment not herein specified or indicated as to manufacturer but necessary for complete functioning systems shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

F. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced by the Contractor to the full satisfaction of the Owner's Representative.

2.2 MANUFACTURER'S EQUIPMENT NAMEPLATES

A. All equipment shall have factory applied permanent nameplates indicating the manufacturer's name, model and serial numbers, and any other data necessary to conform to specified requirements.

2.3 EQUIPMENT PADS AND ANCHOR BOLTS

A. Concrete equipment pads shall be provided for all indoor floor-mounted and outdoor grade-mounted electrical equipment.

B. The size and configuration of the equipment pad(s) and anchor bolt or other fastening requirements shall coordinate with and shall be suitable for the equipment to be installed. The Contractor shall be responsible for coordinating all requirements prior to forming and pouring the concrete.

C. All concrete work shall conform to the requirements of Division 03 of these Specifications.

D. Unless otherwise indicated, indoor equipment pads shall be 2 inches larger all around and outdoor equipment pads shall be 6 inches larger all around than the equipment base. All equipment pads shall have a 1-inch chamfer all around the top edge.

E. Equipment pads shall be poured true and level and shall have a smooth finish.

F. Unless otherwise indicated, equipment pads located indoors shall be 3-1/2 inches above finished floor and equipment pads located outdoors shall be 6 inches above finished grade.

G. Equipment pads shall have size 4 reinforcing steel rods located within the pad as indicated in the Equipment Pad Details shown on Drawing E-501.

H. Unless otherwise indicated, all equipment shall be properly anchored to the outdoor equipment pad, or the concrete floor beneath the indoor equipment pad, using an approved means of fastening, meeting all seismic requirements of the International Building Code (latest edition).

I. Anchor bolts shall be provided where necessary and shall be type 304 or 316 stainless steel outdoors or galvanized steel indoors. Installation of anchor bolts shall be in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

2.4 PAINTING AND FINISHES

A. All purchased equipment shall have a factory applied standard finish of the manufacturer's standard color unless otherwise specified.

B. Finishes which are marred during shipping, handling, or installation shall be touched up by the Contractor to match the original finish using primer and paint furnished by the equipment manufacturer.

2.5 EQUIPMENT TAGGING

A. All equipment and materials shipped under these Specifications shall be properly tagged with the name of the item, name of the project and project address, and shall bear the Contractor's name.

PART 3 - EXECUTION

3.1 SCOPE OF THE WORK

A. The Contractor shall provide all labor, materials, equipment, tools, supervision, and services required for the complete installation of all electrical work as shown on the Drawings and described in these Specifications.

B. The work under Divisions 26 of the Specifications includes, but is not limited to, the following items:

1. Preventative maintenance on existing 4.16kV utility metering switchgear in Ameren Missouri substation and 4.16kV main switchgear inside the Power Plant
2. Demolition of existing panelboards, motor control centers, Power Plant diesel-engine-generator circuit breaker and control panel.
3. Demolition of existing medium-voltage feeder cables and raceways, < 600V feeder and branch circuit conductors, cables, raceways, boxes, and equipment
4. Demolition of existing control conductors, cables, raceways, boxes, and devices
5. Disconnection, handling, relocation and/or reconnection of existing equipment and electric power and rerouting of existing power and control circuits as required and as shown on the Drawings
6. Removal and disposal off site of the existing equipment and materials to be removed
7. Trenching, excavating and backfilling for underground raceways and conduit duct banks
8. Concrete encased electrical duct banks
9. Underground conduits
10. Medium-voltage power cable and terminations
11. Feeder and branch circuit wiring and raceways

12. Control conductors, cables, raceways, boxes and devices
13. Motor power and control circuit wiring, raceways, equipment and components
14. Grounding and bonding
15. Junction and pull boxes
16. Protective device coordination study and arc flash risk assessment
17. Concrete equipment pads
18. Medium-voltage fusible load-interrupter switchgear
19. Neutral grounding resistor
20. Panelboards
21. Motor control center
22. Wiring devices and cover plates
23. Fuses and circuit breakers
24. Enclosed switches
25. Motor control
26. New control system, including control panel, for existing diesel-engine-driven generator in the Power Plant
27. Medium-voltage generator connection cabinet
28. Medium-voltage automatic transfer switch

C. The Contractor shall furnish and install all control and power wiring required for the control system upgrade to the existing Power Plant diesel-engine-driven generator including all control/annunciator panels and the new remote radiator, indoor fuel oil day tank, and generator room ventilation system. It may become necessary to modify the interconnecting control wiring from that shown on the Drawings in order to accommodate the control system diagrams provided by the manufacturers of the systems. To this extent, the Contractor shall make all such accommodations at no additional cost to the Owner

3.2 SHIPMENT AND DELIVERY

A. The Contractor shall be responsible for the furnishing and safe delivery of all materials and equipment required for the project and for the safekeeping of all material and equipment until final acceptance by the Owner's Representative.

B. The Contractor shall be responsible for protecting all electrical equipment intended exclusively to function indoors. Such equipment must be stored indoors and protected against exposure to or accumulation of dust, moisture, freezing, flooding, corrosion or other form of damage. The Contractor shall clean and restore damaged finishes as required to place the installation in a "like new" condition before acceptance by the Owner.

3.3 SAFETY MEASURES

A. The Contractor shall arrange his work in such a manner that a minimum of interference will be experienced with the operations of the Owner or with traffic, both pedestrian and vehicular, either in the vicinity of or on the project site.

B. The blocking of thoroughfares shall be kept to a minimum and shall be coordinated with the Owner's Representative and authorities have jurisdiction.

C. The Contractor shall comply with the U.S. Department of Labor-Occupational Safety and Health Administration (OSHA) - Occupational Safety and Health Standards, all local and state public safety regulations and provide such safety measures as signs, signals, road blocks, safety lights, railings, guards, temporary walkways, crossings and similar safety equipment as may be required for the adequate protection of the public, the Owner's personnel, workmen engaged on the project, and property.

3.4 WORK VERIFICATION AND FIELD MEASUREMENTS

A. The Contractor shall verify the voltage, phase, full-load current and exact location of all electrical equipment before rough-in.

B. The Contractor shall note that the configuration and dimensions of actual equipment may vary from that shown on the Drawings depending on the equipment supplied. The Contractor shall be responsible for making the necessary modifications to connecting conduit, bases, etc. required by the equipment supplied.

C. All dimensions and clearances affecting the installation of work shall be verified at the project site in relation to established datum, to existing items and conditions, and to the work of other trades.

D. The Contractor shall assume responsibility for proper installation of materials in the space available.

E. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.

F. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Owner's Representative and/or Designer shall be notified, and any changes shall be approved before proceeding with the Work.

G. Where crowded locations exist and where there is a possibility of conflict between the trades, the Contractor shall make composite drawings showing the exact locations of the items in question (pipes, ducts, conduits, equipment, etc.). Drawings shall be based on actual measurements, after consultation and agreement between the trades, and shall be approved by the Designer before installation of the Work.

H. The Contractor shall provide all necessary offsets, raises or drops in conduits and fixtures as required by existing conditions at no additional cost to the Owner.

I. The location of all items shall be obtained from the Drawings. The Owner's Representative and/or the Designer shall be allowed to relocate any item within a 10-foot radius from the scaled location on the plans without additional cost to the Owner, provided this is done prior to or during rough-in and before finish installation.

3.5 ELECTRICAL WORK DEMOLITION AND RELOCATION OF EXISTING EQUIPMENT

A. See Section 260505 – Selective Demolition for Electrical in these Specifications.

3.6 MOUNTING HEIGHTS

A. Unless otherwise indicated elsewhere in these Specifications or Drawings, mounting heights of wiring devices and equipment shall be in accordance with the following schedule.

B. The following item mounting heights shall be above finish grade, floor or work platform to the horizontal centerline of the item.

Item		Mounting Height
1.	Toggle switches	4 feet 0 inches
2.	Receptacles (indoors)	4 feet 0 inches
3.	Receptacles (outdoors)	2 feet 0 inches
4.	Control stations, selector switches, push button controls and EPO stations	4 feet 0 inches
5.	Manual motor starters	4 feet 0 inches
6.	Ameren revenue meter	5 feet 0 inches

C. The following item mounting heights shall be above finish floor/work platform to the top of the item.

Item			Mounting Height
1.	Panelboards		
	a.	< 5'-8" tall enclosure	6 feet 0 inches
	b.	≥ 5'-8" tall enclosure	Install on 3.5" high concrete equipment pad per Article 2.3 of this Section
2.	Enclosed switches		
	a.	30-60-100A	5 feet 6 inches
	b.	200A and larger	6 feet 0 inches
3.	Control panels		
	a.	36" high or less	5 feet 6 inches
	b.	Greater than 36" high	6 feet 0 inches

3.7 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment, equipment supports, raceways, or hangers to building structures shall be subject to approval by the Owner's Representative at all times.

B. Support of electrical equipment and raceways shall be provided in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

3.8 CUTTING, PATCHING AND REPAIRING

A. The Contractor shall be responsible for all cutting required for and resulting from the installation of his work, except where noted otherwise. The Contractor shall patch and repair the holes and restore the surface finish.

B. The Contractor shall place sleeves for conduits that must pass through foundations, walls, and slabs ahead of concrete pouring. Failing in this, the Contractor shall do the necessary cutting and sealing thereafter in an approved manner.

C. Under no circumstances shall any structural members, load bearing walls, building columns or footings be cut without first obtaining written permission from the Designer.

D. Cutting shall be in accordance with the following.

1. Concrete and Masonry: All openings for conduit shall be core drilled. Square or rectangular openings shall be saw cut.

E. Patching shall be in accordance with the following.

1. Non-fire Rated Concrete and Masonry: Patch the opening with Sika Top 122 Plus (Sika Corp.) non-shrink grout or approved equal, finished smooth with adjacent surface.

2. Fire-rated Construction: In accordance with Section 260533.13 – Conduit for Electrical Systems.

3.9 ELECTRICAL TESTS

A. The Contractor shall, after the installation is completed, visually inspect all items to ascertain that each item is not damaged and is in proper working condition, and shall test all circuits and demonstrate to the satisfaction of the Owner's Representative and/or Designer, the following:

1. That all power and control circuits are continuous and free from short circuits and unspecified grounds.

2. That the resistance to ground of all ungrounded circuits operating below 600 volts is 50 megohms or greater at a test voltage of 1000 VDC.

3. That all circuits are properly connected to the correct phase and in accordance with the Drawings and applicable wiring diagrams. Circuits shall be numbered as shown on the Drawings and connected to equalize the loading on all phases.

4. That all circuits and equipment are operable. Demonstration shall include the proper functioning and operation of each unit to the Owner's satisfaction, and the continuous operation of all power circuits for not less than 24 hours.

5. That all equipment requiring calibration and adjustment has been properly calibrated and adjusted in accordance with its intended function and the manufacturer's recommendations.

6. That all equipment and systems function properly.

7. That the phasing sequence and synchronization is the same throughout the entire electrical system. The Contractor shall be responsible for the correct phase rotation on all motors and devices. Any item that is damaged as a result of improper rotation or phasing shall be replaced by the Contractor at no additional cost to the Owner.

B. Perform testing in accordance with the requirements of each section of the Division 26 specifications as applicable.

C. All tests shall be made after notification to and in the presence of the Owner's Representative and/or Designer and the authorities having jurisdiction, if required.

D. The cost of labor, materials, instruments and supplies of any kind required for testing shall be borne by the Contractor.

E. Before starting up any system, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, continuity of controls, and any other condition which could cause damage to equipment or endanger personnel.

F. Test runs shall be made over the full design load range where possible, or simulated to the satisfaction of the Owner's Representative for other conditions. During test runs all necessary adjustments shall be made, controls checked for proper operation, motors checked for possible overload, and the entire system checked by the Contractor for any abnormal condition.

G. During the test runs and prior to acceptance of any system, the Owner's designated operating personnel shall be instructed in the operation and maintenance of the system.

H. Material and equipment damaged or shown to be defective during tests, unable to perform at design or rated capacity, or not in accordance with the Specifications shall be repaired or replaced by the Contractor to the full satisfaction of the Owner's Representative at no cost to the Owner.

3.10 START UP

A. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's Representative.

B. The Contractor shall provide qualified personnel to perform start up assistance and final acceptance testing of all equipment after it has been completely installed and is ready to be energized, prior to applying voltage.

C. When the Contractor, Designer and Owner's Representative agree that the new diesel-engine-driven generator automatic control system is ready for final acceptance testing, Contractor shall arrange for Ameren Missouri to come to the site for acceptance testing.

D. The Contractor shall be responsible for the operation and maintenance, including all costs thereof, for systems or equipment temporarily placed in operation for testing and adjusting purposes, or for the convenience or necessity of the Contractor prior to final acceptance by the Owner.

E. The Contractor shall instruct the Owner's operating personnel in the operation and maintenance of the electrical equipment during energization but prior to acceptance by the Owner.

3.11 TEMPORARY POWER

A. The Moberly Correctional Center is a 24/7/365 high-medium security, Custody Level 4 correctional institution and as such, requires that electrical power be maintained during the execution of the work specified in the plans and these specifications.

B. The Work will require interruptions of the primary incoming 4.16 kV power to the facility. The 1,450 kW standby rated diesel-engine-driven generator at the Power Plant provides backup power for the entire facility. However, the generator is connected to the same 4.16 kV main switchgear inside the Power Plant as Ameren Missouri normal utility feeder so no power will be available to the facility when work is taking place that requires the 4.16 kV main switchgear be de-energized. Work that requires the 4.16 kV main switchgear in the Power Plant to be out of service is limited to 8 hours so it is not anticipated that a temporary generator will need to be provided to power the entire facility.

C. A Contractor shall use the existing diesel-engine-driven generator to power the facility when Ameren power is disconnected for relocation of the Ameren utility metering switchgear and installation of the new outdoor 4.16 kV service entrance fusible load-interrupter switchgear. The fuel level in the Owner's fuel oil storage tanks shall be recorded prior to use of the Power Plant generator to power the facility, and the Contractor shall have diesel fuel added to the tanks to replace all fuel used by the Contractor.

D. The Contractor shall furnish a temporary trailer mounted diesel-engine-driven emergency generator, including a step-up transformer, if required, to provide auto-start emergency generator backup for the facility during the time the facility's permanently installed emergency generator is out of service for the controls upgrade, remote radiator replacement, indoor fuel oil day tank replacement and the generator room ventilation upgrade. The Contactor supplied temporary generator shall be connected to the 4.16kV main switchgear in the Power House via the new medium-voltage generator connection cabinet specified in Section 263290 – Medium-Voltage Generator Connection Cabinet. The minimum size for the temporary emergency generator shall be 1000 kW during the period from October 15 to April 15 and 1250 kW during the period from April 16 to October 14.

E. The Contractor shall be responsible for all costs associated with the temporary generator, including but not limited to, the diesel-engine-generator, step-up transformer (if required), 5 kV cables, 480V cables (if required), delivery and pickup of the rented equipment, all fuel used and any other charges levied by the generator rental company..

F. The location of the temporary generator and the step-up transformer, if required, and the routing and protection of all temporary cables shall be subject to approval by the Owner's Representative..

G. The temporary generator(s) shall be in good, reliable condition, less than five years old, and subject to the approval of Owner's Representative.

H. The Contractor shall be solely responsible for maintaining and servicing the temporary generator during the construction period including all fuel, oil, filters, etc.

END OF SECTION 260500

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

ATTACHMENT 1 - ASCE Design Hazards Report – Moberly Correctional Center

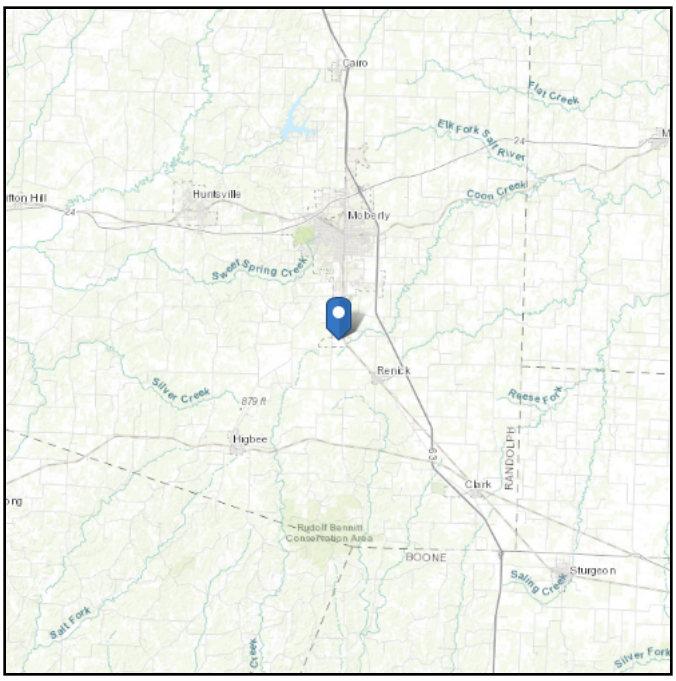
ASCE Hazards Report

Address:
Moberly Correctional Center - 5201 S Morley St
Moberly,

Standard: ASCE/SEI 7-22
Risk Category: IV
Soil Class: D - Stiff Soil

Latitude: 39.362414
Longitude: -92.440482
Elevation: 880.3095060471999 ft (NAVD 88)





Wind

Results:

Wind Speed	120 Vmph
10-year MRI	75 Vmph
25-year MRI	82 Vmph
50-year MRI	88 Vmph
100-year MRI	93 Vmph
300-year MRI	102 Vmph
700-year MRI	109 Vmph
1,700-year MRI	116 Vmph
3,000-year MRI	120 Vmph
10,000-year MRI	130 Vmph
100,000-year MRI	149 Vmph
1,000,000-year MRI	169 Vmph

Data Source: ASCE/SEI 7-22, Fig. 26.5-1D and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed: Tue May 20 2025

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-22 Standard. Wind speeds correspond to approximately a 1.6% probability of exceedance in 50 years (annual exceedance probability = 0.00033, MRI = 3,000 years). Values for 10-year MRI, 25-year MRI, 50-year MRI and 100-year MRI are Service Level wind speeds, all other wind speeds are Ultimate wind speeds.

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-22 Section 26.2.

Seismic

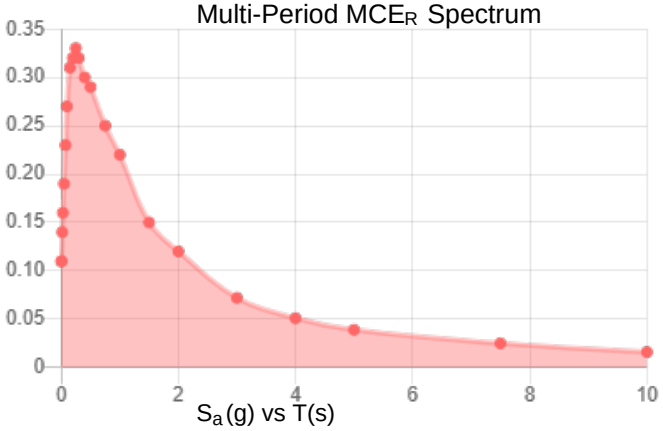
Site Soil Class: D - Stiff Soil

Results:

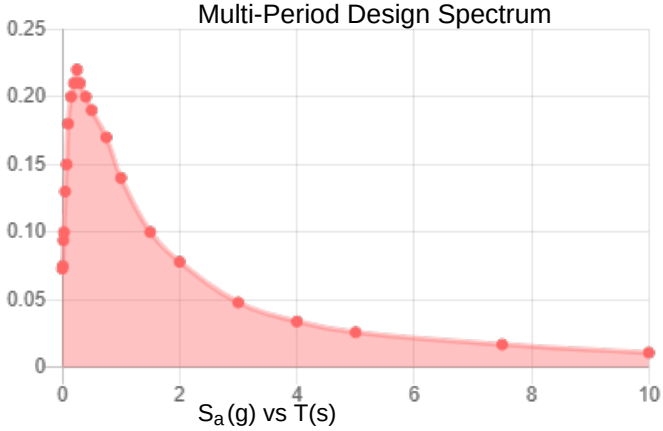
PGA_M :	0.1	T_L :	12
S_{MS} :	0.3	S_S :	0.23
S_{M1} :	0.22	S_1 :	0.1
S_{DS} :	0.2	V_{S30} :	260
S_{D1} :	0.14		

Seismic Design Category: D

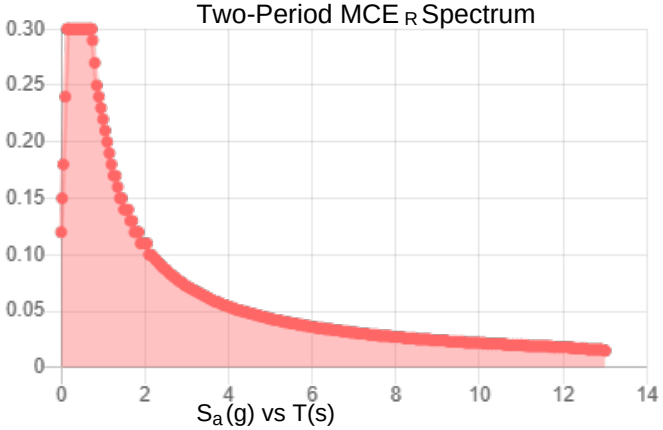
Multi-Period MCE_R Spectrum



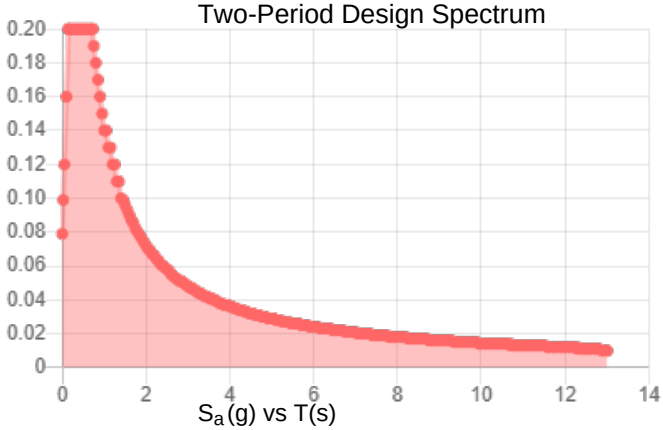
Multi-Period Design Spectrum



Two-Period MCE_R Spectrum



Two-Period Design Spectrum



MCE_R Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Data Accessed: Tue May 20 2025

Date Source:
USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.

Ice

Results:

Ice Thickness:	2.00 in.
Concurrent Temperature:	5 F
3-s Gust Speed	45 mph
Data Source:	Standard ASCE/SEI 7-22, Figs. 10-2 through 10-8
Date Accessed:	Tue May 20 2025

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain for 250, 500, 1,000, and 1,400-year mean recurrence intervals along with concurrent 3-s gust speeds and concurrent air temperatures. The shading indicates special icing regions, with elevations above 2,100 ft (640 m) in the east, 6,000 ft (1829 m) in the west, and 1,600 ft (488 m) in Alaska, with sparse weather station data for determining design ice loads. In these regions, as well as in regions with complex terrain causing unusual icing conditions and regions where snow or in-cloud icing results in larger loads, the mapped values should be adjusted based on a combination of local historical records and experience, reanalysis data, and numerical weather prediction systems.

Snow

Results:

Ground Snow Load, p_g :	38 lb/ft^2
20-year MRI Value:	11.13 lb/ft^2
Winter Wind Parameter:	0.55
Mapped Elevation:	869.8 ft
Data Source:	ASCE/SEI 7-22, Figures 7.6-1 and 7.6-2 A-D
Date Accessed:	Tue May 20 2025

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported ‘elevation’ and ‘mapped elevation’ differ significantly from each other.

Ground Snow Loads for IRC only, $p_{g(asd)}$:	26.6 lb/ft^2

Rain

Results:

15-minute Precipitation Intensity:	8.21 in./h
60-minute Precipitation Intensity:	4.45 in./h

Data Source: NOAA National Weather Service, Precipitation Frequency Data Server, Atlas 14(https://www.nws.noaa.gov/oh/hdsc/)

Date Accessed: Tue May 20 2025

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SECTION 260505 – SELECTIVE DEMOLITION FOR ELECTRICAL

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 SCOPE

A. This Section includes demolition and removal of selected portions of facility required for new construction.

1.3 DESCRIPTION OF WORK

A. Furnish all materials, labor, equipment and services necessary to perform all electrical demolition work.

B. Work included in this Section includes all demolition work as shown on the Electrical Drawings and as specified herein and as required to complete the Work.

1.4 RELATED SECTIONS

A. Section 024119 – Selective Demolition

B. Section 230505 – Selective Demolition for HVAC

C. Section 260500 – Common Work Results for Electrical

1.5 DEFINITIONS

A. Demolish: Completely remove and legally dispose of off-site.

B. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

C. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

D. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

E. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

F. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner. Include fasteners or brackets needed for reattachment elsewhere.

1.6 SUBMITTALS

A. Schedule of Selective Electrical Demolition Activities: Indicate detailed sequence of selective electrical demolition and removal work, with starting and ending dates for each activity and interruption of electric power services.

B. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

C. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective electrical demolition operations. Submit before the Work begins.

D. Disposal Records: If hazardous wastes are removed by Contractor, submit the following:

1. Hazardous Waste Transporter license
2. Permit or license for hazardous waste treatment or disposal facilities
3. Completed Uniform Hazardous Waste Manifest for all shipments
4. Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

C. Prior to beginning demolition, arrange a conference with the Construction Representative to review electrical demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.8 PROJECT CONDITIONS

A. Owner will occupy the facility during construction. Localized areas to be demolished will be vacated during demolition work. Conduct selective electrical demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Construction Representative of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. On-site storage or sale of removed items or materials is not permitted.

E. Utility Service: Maintain electrical service to building/facility during selective electrical demolition operations.

1. Disconnect electrical power only to the items of equipment or the panelboard that is identified for removal under the selective electrical demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.10 MATERIALS OWNERSHIP

A. Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

1.11 COORDINATION

A. Arrange demolition schedule so as not to interfere with Owner's on-site operations and the operations of adjacent occupied buildings.

B. Review and finalize selective electrical demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

C. Review requirements of General Demolition Contractor and work performed by other trades that rely on demolition of electrical circuitry or equipment to allow for structural demolition or removal of equipment.

D. Review areas where existing electrical circuitry and/or equipment is to remain in place and requires protection.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

A. Verify that utilities have been disconnected and capped before starting selective electrical demolition operations.

B. Survey existing conditions and coordinate and identify the extent of the electrical demolition work required. Record existing conditions using preconstruction photographs.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.

D. When unanticipated site, mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Construction Representative and Designer.

E. Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

A. No electrical demolition work shall be performed without prior approval of the Construction Representative.

B. Electrical demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.

C. Any electrical demolition work which interferes with Owner's operation shall be scheduled with the Construction Representative and be subject to the Owner's approval.

D. Maintain existing services required to avert disruption to the Owner's on-going operations and protect them against damage during the performance of the work.

E. Do not interrupt existing electrical service to occupied facilities except when authorized in writing by the Construction Representative.

F. Provide temporary electrical service during interruptions to existing electrical systems, as acceptable to the Construction Representative.

G. Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of electrical service is required during the execution of the work.

H. The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Construction Representative. Any such material removed shall be replaced by the Contractor at his expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

I. All damages to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the workers responsible for the repair and restoration leave the job on the day such interruptions occur.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective electrical demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. Existing building openings may be used to remove material. No new openings may be made without approval of the Construction Representative.

3.4 PROTECTION

A. Comply with governing laws, codes, and regulations governing fire protection and environmental protection during electrical demolition operations.

B. Provide dust control and ventilation as required in areas of electrical demolition.

C. Execute electrical demolition work, so as to insure adjacent areas against damage which might occur from falling debris or other causes; do not interfere with the use of, operations in, or around adjacent areas; maintain free and safe passage of persons around the areas of electrical demolition.

D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the electrical demolition work.

E. Premises shall be maintained and protected from all unsafe or hazardous conditions at all times.

F. Protect existing surfaces, active utility services, and equipment which are to remain in place.

G. Protect lighting fixtures, exit signs, fire alarm devices, and other items that are to remain in place from damage during demolition and construction operations. Exposed fixtures and devices shall have a plastic bag or other suitable covering affixed over the item to protect from dust and paint splatters.

3.5 DUST CONTROL

A. Contractor shall use temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt carrying over to other parts of the Owner's property.

B. Adequacy of the dust control methods shall be subject to the approval of the Construction Representative.

C. Areas of major electrical demolition inside the Owner's property shall be enclosed by means of temporary walls constructed of wood framing with plywood or 6 mil polyethylene sheets.

D. Temporary enclosures shall be removed by the Contractor upon completion of the electrical demolition work unless otherwise directed by the Construction Representative.

3.6 ELECTRICAL DEMOLITION - GENERAL

A. Remove all work indicated on the Drawings and as required to complete the new work indicated.

B. During electrical demolition operations, keep areas adjacent to electrical demolition work free of dust and debris.

C. During electrical demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Construction Representative.

D. At concealed spaces, such as hollow walls, ducts, and pipe interiors, verify condition and contents of hidden space before starting electrical demolition operations.

E. Neatly cut openings and holes plumb, square and true to dimensions, required.

F. Use cutting methods least likely to damage construction to remain or adjoining construction.

G. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

H. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

I. Do not use cutting torches until work area is cleared of flammable materials.

J. Maintain portable fire-suppression devices during flame-cutting operations.

K. Contractor shall take care when using a torch to cut steel welded or bolted to structural members so as to cut flush with but not damage the structural members.

L. All hanger and support material for demolished piping and conduit shall be removed back to the primary structural support member. Grind connection to primary member smooth and touch up with paint to match adjacent surface.

M. All elevated equipment and materials to be demolished shall be carefully lowered (not dropped) by means of temporary riggings. Contractor shall not overload any elements of existing structure during the rigging operation.

N. Locate selective electrical demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

O. Dispose of demolished items and materials promptly.

3.7 ELECTRICAL DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality and functionality.

B. The Contractor shall use caution in the demolition of electrical systems and shall inform himself of the status (active, inactive) of all electrical systems to be demolished prior to proceeding.

C. Prior to breaking or cutting conduit within the demolition area, the Contractor shall ascertain that the system has been identified or shown on the Drawings to be wrecked under this Contract. Contact the Construction Representative for clarification prior to demolishing or wrecking questionable items.

D. The Contractor shall remove, cap and/or relocate equipment, outlets, lighting fixtures, conduit, cables, wire, etc., as specified or as shown on the Drawings and as may become necessary because of existing field conditions at no additional cost to Owner.

E. All existing lighting fixtures, switches, receptacles, outlets, etc., shall be removed as required to complete the work and blank covers provided over the outlets, unless otherwise noted.

F. Properly dispose of all lighting fixture lamps and ballasts in accordance with all applicable Federal, State, and local laws and regulations.

G. All concealed conduit for circuits which are partially or completely abandoned may remain in place. Remove all wiring for concealed circuits that are to be completely abandoned and cut and remove concealed conduit 2 inches below the surface of adjacent construction. Cap conduits and patch surface to match existing finish and fire rating. Exposed conduit for abandoned circuits shall be removed, unless otherwise noted.

H. Exposed conduit containing circuits which are to be retained shall remain in place, unless otherwise indicated or required.

I. Wiring for existing circuits which must be rerouted, or which are partially abandoned, shall be reconnected to service the outlets/loads remaining on the circuit.

J. All wiring for a circuit which is to be removed or abandoned shall be removed back to the panel which supplied the circuit.

K. Completely remove all hangers and supports to building structure. Grind off stubs without damaging parent material (steel, concrete, etc.) and touch up paint as required.

L. All abandoned or remaining empty conduit with open ends resulting from demolition work shall be promptly capped, plugged, or sealed.

M. All open conduit knockouts, holes, or unused hubs in electrical boxes and enclosures shall be properly plugged with suitable blanking devices of the same material as the enclosure that maintain the NEMA rating of the enclosure. Utilize NEMA 12 rated hole seal devices to seal all open holes in all NEMA 1 type panelboards, switchboards, switchgear, motor control centers, and dimensioned junction and pull boxes located indoors.

3.8 CONCRETE AND MASONRY DEMOLITION

A. Demolish concrete and masonry in small sections.

B. Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools. Do not use power-driven impact tools.

3.9 PATCHING

A. All holes or openings in floors, walls or ceilings resulting from electrical demolition shall be properly sealed with material similar to the adjacent surface/finish. Patch holes in concrete floors and ceilings where conduits are removed using non-shrink epoxy grout or concrete material to match existing surfaces and construction. Patch holes in walls and partitions where conduits are removed to match existing construction and finish.

B. All rough edges of openings created by electrical demolition shall be promptly patched to create a finished surface.

C. Openings in concrete shall be patched with cement mortar.

D. Openings in masonry shall be patched by toothing in masonry units to match existing.

E. Maintain the fire rating of all floors, walls, partitions and ceilings when patching.

3.10 REMOVED AND SALVAGED ITEMS

A. Carefully remove and clean salvaged items.

B. Pack or crate items after cleaning. Identify contents of containers.

C. Store items in a secure area until delivery to Owner.

D. Transport items to Owner's storage area as directed by Construction Representative.

E. Protect items from damage during transport and storage.

F. The following items are to be salvaged after removal, cleaned and packed or crated as indicated above, and delivered to the Construction Representative at the project site along

with a list of all delivered items, to be signed by the Contractor and the Construction Representative :

1. All Cutler-Hammer Series C molded case circuit breakers from existing MCC1 and MCC2.
2. All fuses removed from existing medium-voltage switchgear and low-voltage electrical equipment.

3.11 REMOVED AND REINSTALLED ITEMS

A. Carefully remove items to be reinstalled.

B. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.

C. Pack or crate items after cleaning and repairing. Identify contents of containers.

D. Protect items from damage during transport and storage.

E. Reinstall items in locations indicated.

F. Comply with installation requirements for new materials and equipment.

G. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

H. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his expense.

3.12 EXISTING ITEMS TO REMAIN

A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective electrical demolition.

B. When permitted by Construction Representative, items may be removed to a suitable, protected storage location during selective electrical demolition and reinstalled in their original locations after selective electrical demolition operations are complete.

3.13 DISPOSAL

A. All debris resulting from electrical demolition operations shall become the property of the Contractor and shall be removed daily from the Owner's property unless otherwise permitted by the Construction Representative.

B. Storage of removed materials on site will not be permitted.

C. Sale of removed materials on-site will not permitted.

D. Transport demolished materials off Owner’s property and dispose of legally in accordance with Federal, State, and local laws and regulations.

E. Upon completion of work, remove tools, materials, apparatus, and rubbish. Leave area clean, neat, and orderly.

3.14 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective electrical demolition operations.

B. Return adjacent areas to condition existing before selective electrical demolition operations began.

3.15 HAZARDOUS MATERIALS

A. The Owner, to the best of his knowledge, does not believe that hazardous materials containing friable asbestos or lead based paint are included in the items to be demolished or the work areas.

B. Should the Contractor discover material requiring removal which is suspected to contain hazardous materials, do not disturb.

C. Contact and consult with the Construction Representative prior to proceeding. The Construction Representative shall direct the Contractor how to proceed.

END OF SECTION 260505

SECTION 260513 – MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to the Work specified in this Section.

1.2 SCOPE

A. Furnish and install all medium-voltage power cables and associated materials as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260526 - Grounding and Bonding for Electrical Systems

C. Section 260533.13 - Conduit for Electrical Systems

D. Section 260533.16 - Boxes for Electrical Systems

E. Section 260553 – Identification for Electrical Systems

F. Section 263290 – Medium-Voltage Generator Connection Cabinet

G. Section 337119.13 – Electrical Underground Ducts

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each of the following items:

1. Medium-voltage power cable
2. Medium-voltage cable splice kits
3. Medium-voltage cable termination kits
4. Medium-voltage cable arc-proofing tapes
5. Medium-voltage cable moisture seals

B. Submit qualification data for medium-voltage cable splice and termination installer certifying adequate training and experience for the specific type of splice kits required for this project.

C. Submit qualification data for medium-voltage cable acceptance testing technician certifying adequate training and experience for the successful performance of the testing required.

D. Submit 15 kV cable preparatory test report prior to commencement of medium-voltage cable acceptance testing.

E. Submit 15 kV cable acceptance test report.

PART 2 - PRODUCTS

2.1 GENERAL

A. All applicable requirements of 2023 National Electrical Code (NEC) Article 305 – General Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal and Article 315 - Medium Voltage Conductors, Cable, Joints, and Cable Terminations shall apply to this Section.

B. Medium-voltage power cable (Type MV) shall be defined as single or multi-conductor solid dielectric insulated cable rated 2001 volts or higher, up to 35,000 volts.

C. All medium-voltage cable, splices and terminations shall be insulated and rated for 15 kV.

2.2 MEDIUM-VOLTAGE POWER CABLE

A. All cable which is to be used for medium-voltage systems shall be Underwriters' Laboratories, Inc. listed Type MV-105 single conductor shielded medium-voltage (MV) power cable having ethylene propylene rubber (EPR) insulation, rated 15 kV. Cable shall be rated to be installed in wet or dry locations, indoors or outdoors, in a raceway, in an underground duct or directly buried. The cable must be triple tandem extruded with an all ethylene propylene insulation system.

1. Conductor: Class B compact stranded per ASTM B-496, uncoated annealed copper per ICEA S-93-639/NEMA WC 74 Section 2, sizes as indicated on the Drawings.

2. Strand Shield: Extruded semi-conducting ethylene propylene rubber (EPR) with 100% EPR construction per ICEA S-93-639/NEMA WC 74 Section 3, ICEA S-97-682, AIEC CS8 and UL 1072. The screen shall not contain any polyethylene.

3. Insulation: Ozone and corona discharge resistant, thermosetting, ethylene propylene rubber (EPR) with 100% EPR construction per ICEA S-93-639/NEMA WC 74 Section 4. The insulation thickness shall be 220 mils for 133% insulation level per ICEA S-93-639/NEMA WC 74 Table 8-3. The minimum spot thickness shall not be less than 90% of the specified thickness. The insulation shall not contain any polyethylene.

4. Insulation Shield: Extruded semi-conducting ethylene propylene rubber (EPR) with 100% EPR construction applied over the insulation per ICEA S-93-639/NEMA WC 74 Section 5, ICEA S-97-682, AIEC CS8 and UL 1072. The insulation shield shall not contain any polyethylene.

5. Shield: Bare uncoated 5 mil thick, or overlapped 3 mil thick, copper tape helically applied over the insulation shield with a 12.5% minimum overlap per ICEA S-93-639/NEMA WC 74 Section 6.

6. Jacket: Black polyvinylchloride (PVC) per ICEA S-93-639/NEMA WC 74 Section 7 having the following minimum thickness:

   a. 80 mils: 2 AWG to 500 KCM

7. Temperature Rating, Continuous Use:

   a. 105°C normal operation, wet or dry locations

   b. 140°C emergency overload

c. 250°C short circuit conditions

8. Testing: All cables shall be flat line corona tested with less than 5 picocoulombs by cable manufacturer in accordance with the applicable requirements of ICEA S-93-639/NEMA WC 74, AEIC CS8, UL 1072 and IEEE 383.

9. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-93-639/NEMA WC 74, ICEA S-97-682, AEIC CS8, UL 1072 and IEEE 383.

10. Identification: Surface printing on the cable jacket shall show manufacturer's name, conductor size, conductor material, insulation type, jacket type, voltage rating, nominal insulation thickness, year of manufacturer, insulation level, and UL designations.

11. Manufacturer: Okonite, Prysmian or Kerite – No substitutions allowed.

2.3 MEDIUM-VOLTAGE CABLE IN-LINE SPLICES

A. In-line splices for medium-voltage power cables shall be made using copper, long-barrel compression connectors, 3M 11000 Series (for conductor sizes ≥ 2/0 AWG) and standard-barrel compression connectors, 3M 10000 Series (for conductor sizes ≤ 1/0 AWG) or approved equals by Burndy or Hubbell-Anderson/Fargo, in watertight cold shrink rubber splicing kits that meet the requirements of IEEE 404.

B. All splicing kits shall be suitable for the voltage rating and physical size of the cables and shall have continuous ampacity which is equal to or greater than that of the cable. Stress relief shall be developed at all splices.

C. All splice kits shall have a 150 kV BIL rating and shall have a direct current 15 minute withstand rating of 75 kVDC minimum and shall be suitable for use on Type MV-105 cable with a maximum rated operating temperature of 105°C.

D. All in-line single conductor 15 kV shielded power cable splice kits shall be cold shrink type, 3M QS-III 551_A Series silicone rubber in-line splice kit or approved equal by Elastimold or Raychem Corporation.

2.4 MEDIUM-VOLTAGE CABLE TERMINATIONS WITH SKIRTED STRESS CONES

A. Medium-voltage cable end terminations in equipment without load break or dead break bushings shall be made using two-hole, rectangular tongue, tin-plated copper compression connectors with long barrel length to permit two (2) crimps as manufactured by Burndy, Hubbell-Anderson/Fargo, Thomas & Betts, or 3M Company.

B. All termination kits shall be suitable for the voltage rating and physical size of the cables and shall have continuous ampacity which is equal to or greater than that of the cable. Cable end terminations shall include skirted stress cones and cable stress relief.

C. All termination kits shall have a 150 kV BIL rating and shall have a direct current 15 minute withstand rating of 56 kVDC minimum and shall be suitable for use on Type MV-105 cable with a maximum rated operating temperature of 105°C.

D. All single conductor 15 kV shielded power cable end termination kits shall be rated Class 1 (IEEE 48, latest edition) and shall be cold shrink type, 3M QT-III 76_ _ -S Series silicone rubber termination kit or approved equal by Elastimold or Raychem Corporation.

E. Provide standard skirt or inverted skirt as required based on orientation of cable termination at the equipment to ensure the skirts are oriented with the "belled" side facing vertically downward.

2.5 MEDIUM-VOLTAGE CABLE DEAD-BREAK TERMINATION KITS

A. Separable connectors shall be 600A, dead-break modular terminations that meet or exceed IEEE Standard 386.

B. Each dead-break elbow connector shall have a hot-stick stainless steel pulling eye for easy removal of the connector from the equipment, a rubber locking ring to firmly seat and lock in place the male contact, a built-in, factory tested, molded stress relief for proper termination of the 15 kV shielded cable, a molded conductive connector shield, a grounding eye for external connection to ground of the cable and connector shields, a capacitive test point and a metallic shield adapter for shield grounding. Connectors shall be of quick-make, quick-break design.

C. Dead-break elbow connectors shall be rated for 600 amperes RMS continuous operation, 1000 amperes RMS 24 hour overload, 25 kV standard voltage class, 15.2 kV maximum phase-to-ground operating voltage, 125 kV BIL (1.2 x 50 microsecond wave), withstand 40 kV AC 60 Hz for one minute and 78 kV DC for 15 minutes, 40,000 amperes RMS symmetrical for 0.2 seconds and 27,000 amperes RMS symmetrical for 4.0 seconds.

D. Dead-break elbow connectors shall be compatible with the bushing insert modules on the medium-voltage generator connection cabinet specified in Section 263290 – Medium-Voltage Generator Connection Cabinet.

E. Separable dead-break connectors shall be 3M Series 5815, or approved equal by Raychem Corporation or Elastimold, with appropriate size cable adaptor kit.

2.6 MEDIUM-VOLTAGE CABLE PULLING LUBRICANT

A. Cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL Listed. The lubricant shall contain no greases, silicones, or polyalkylene glycol oils or waxes.

B. A 200-gram sample of the lubricant, when placed in a one-foot, split metal conduit and fully dried for 24 hours at 105°C, shall not spread a flame more than three inches beyond a point of ignition at a continued heat flux of 40 kW/M^2. Total time of test shall be one-half hour.

C. Cable pulling lubricant shall meet the following minimum specifications:

1. Lubricity at 200 lbs/ft Normal Pressure:

   a. PVC or XLP jacketed cable/PVC conduit
   Coefficient of dynamic friction……≤ 0.15

   b. PVC or XLP jacketed cable/HDPE duct
   Coefficient of dynamic friction…… ≤ 0.15

2. Percent Non-Volitle Solids……...≤ 5.5%

3. Temperature Use Range……...20°F to 110°F

4. pH…….≥ 6.5, ≤ 9.0

5. Flammability……...…..……No Flash Point

6. Polyethylene Stress Cracking……....None/ASTM D1693

7. Temperature Stability:

   a. < 10% change in Brookfield viscosity from 40°F to 100°F
   No separation after five freeze/thaw cycles or 24-hour exposure at 120°F

D. Cable pulling lubricant shall be:

1. POLYWATER® J

2. 3M WL

3. Approved equal by Ideal

2.7 MEDIUM-VOLTAGE CABLE ARC-PROOFING TAPES

A. *Arc-Proofing Tape*: 3M Scotch 77W (white/light gray), 30 mils thick, 1.5 inch or 3-inch-wide, non-adhesive

B. *Glass Cloth Tape*: 3M Scotch 69, 7 mils thick, 3/4-inch-wide with high-temperature thermosetting silicone adhesive

C. *Insulating Tape*: 3M Scotchrap 50, 10 mils thick, 2-inch wide

2.8 MEDIUM-VOLTAGE CABLE MOISTURE SEALS

A. Cable moisture seal end caps shall provide an environmental seal for ends of non-energized medium-voltage cable.

B. End caps shall be close-ended, tubular rubber sleeves that are factory expanded and loaded onto a removable core, 3M Cold Shrink EC Series or approved equal by Elastimold or Raychem Corporation.

PART 3 - EXECUTION

3.1 MEDIUM-VOLTAGE CABLE INSTALLATION

A. All 15 kV cables shall be installed in existing and new underground duct bank ducts and rigid metal conduits as indicated on the Drawings.

B. All cable ends shall be kept sealed prior to installation and immediately following installation, until splices or end terminations are made, using cold shrink end caps as recommended by the cap manufacturer for the cable outside diameter over the outer jacket to keep moisture out of the cable.

C. Examine ducts, raceways, pull boxes, and other cable installation locations for cleanliness of duct/raceway, minimum bending radii of cables, and conditions affecting performance of cable.

D. Proof duct/raceway prior to installing cables to verify suitable conditions by passing a wire brush mandrel and then a rubber duct swab through the duct. Pull the wire brush and rubber swab through the duct at the same time with the rubber swab located 48 to 72 inches behind the wire brush on the pull rope. Do not proceed with cable installation until unsatisfactory conditions have been corrected.

1. *Wire Brush Mandrel*: Wire bristle brush approximately the same size as conduit inner diameter with stiff steel bristles and an eye on each end for attaching to the pull ropes. If obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. *Rubber Duct Swab*: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching to the pull ropes. Pull the rubber duct swab through the duct to extract the loose debris dislodged by the wire brush mandrel from the duct.

E. Measure all raceways to accurately determine the exact lengths of cable required, before installation.

F. Verify and inspect each end of every shipping length of cable for water in strands and check dimensionally for conformance with indicated standards.

G. Observe all National Electrical Code, National Electrical Safety Code and IEEE 576 requirements regarding installation of medium-voltage cables.

H. Install cables and accessories in compliance with manufacturer's recommendations and written instructions. Adhere to recommendations for cable and ambient temperatures at time of installation.

I. Cable reels should be held in warm storage area at temperature of at least 60°F (16°C) for 24 hours to ensure total warm-up. Prior to installation, cables should be handled, if temperature is lower than 20°F, in the 24-hour period proceeding pulling and bending. If no indoor warming area is available a plastic sheeting covering shelter may be constructed and heat provided by Contractor.

J. All cables shall be installed directly from reels. Cables shall not be pulled along the ground or subjected to treatment that may cause abrasion or other damage to the cable jacket or insulation.

K. Pull conductors simultaneously where more than one cable is indicated in same raceway. Use UL listed and manufacturer approved pulling compound or lubricant. Avoid twisting, kinking or abrasion of cables and observe manufacturer's bending radius requirements.

L. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values during installation of cables. Utilize pulling tension measuring equipment and submit a table of the maximum pulling tension measured during each cable pull.

M. Use pulling means, including fish tape, cable, rope and pulling eye that will not damage cables or raceways. Do not use rope hitches or basket weave wire/cable grips for pulling attachment to cable. Utilize pulling eyes that mechanically fasten to the conductor of each cable in the raceway to distribute the pulling tension equally on all cables.

N. Use pull-in guides, cable feeders, pulleys, and draw-in protectors as required to protect cables from damage during installation.

O. Seal all cable ends with the specified cable moisture seals or rubber tape before pulling in to prevent moisture in duct from infiltrating the cable jacket and insulation. Do not pull cables with ends unsealed.

P. Pull cable continuously and without starting/stopping/starting.

Q. Care shall be taken not to damage cables during installation. The Construction Representative shall be notified of any damage, and the Designer will evaluate repairs or replacement.

R. Install sufficient length of cable to allow removal of ends damaged during installation. Remove damaged ends, or the last 3 feet of cable, whichever is longer, on each end after installation in raceway and before termination.

S. Install medium-voltage power cable with adequate bending radius in accordance with the National Electrical Code and the cable manufacturer's recommendations:

1. Greater than twelve (12) times the cable outside diameter for medium-voltage, shielded cable.

T. The grounding conductor associated with each set of medium-voltage cables shall be bonded to the cable support bushing and/or conduit grounding bushing inside each pull box and all electrical equipment enclosures and shall be connected to the equipment ground bus inside the electrical equipment at each end of the cable run.

3.2 MEDIUM-VOLTAGE CABLE SPLICE AND TERMINATION INSTALLATION

A. Install in-line splices at pull points as specified herein and as indicated on the Drawings. Cables shall not be spliced inside electrical equipment. Cables that area too short for terminating in equipment shall be removed and replaced.

B. All medium-voltage power cable splices and end terminations shall be made using kits specifically designed for the particular application. The splice kit and termination kit manufacturer's instructions for performing the work shall be rigidly followed.

C. It shall be this Contractor's responsibility to furnish, deliver and install the exact sizing and type of connection necessary for each splice and termination using the special tools that are required for the installation.

D. Unless the Contractor's cable splicer has documented first-hand experience with installation of the exact type of splice and termination kits required for this project, the manufacturer of the splice and termination kit equipment shall field instruct the Contractor's personnel on creating a satisfactory connection by demonstration of at least one single cable splice and termination, of each different type used on this project, in the presence of the Construction Representative.

E. Splices and terminations shall only be performed by personnel trained and experienced in the installation of this type of materials. Submit the qualifications of cable splicer for review prior to commencement of any work in the field.

F. All splicing and terminating kits shall be suitable for the voltage rating and physical size of the cable and shall have continuous ampacity which is equal to or greater than that of the cable. Dead-break elbows or skirted stress cones shall be provided for terminations as required based on the equipment, and stress relief shall be developed at all terminations.

G. Tighten electrical connectors and terminals in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

H. The electrical continuity of the cable shield shall be maintained across each cable splice in accordance with the manufacturer's written instructions. Cable shields shall be grounded at each cable splice unless otherwise indicated.

I. Ground shields of shielded cable at all terminations. Ground metal bodies of terminations, cable connector fittings and hardware in accordance with the manufacturer's written instructions.

3.3 MEDIUM-VOLTAGE CABLE ARC-PROOFING

A. Apply arc-proofing tape to the entire exposed length of all medium-voltage power cables which have been spliced in a junction box, handhole or manhole per the arc-proofing tape manufacturer's written instructions after installation of the specified type of splice kits and successful completion of DC HiPot testing.

B. Cables shall be cleaned of all oil, grease and cable pulling compounds using suitable cleaners and solvents that are non-injurious to the cable and then wiped completely dry.

C. The cables shall be trained as closely as possible to their final positions.

D. Bundle the three (3) cables of each circuit together and wrap arc-proofing tape around the three-conductor bundle rather than around each individual cable extending the arc-proofing tape over the splice kits themselves. The equipment grounding conductor is not to be wrapped with arc-proofing tape.

E. If required, any projecting surfaces such as fittings, ground or bonding connections shall be covered with insulating compound, or wrapped with one half-lapped layer of 2-inch wide insulating tape, to present a smooth continuous surface for arc-taping.

F. One half-lapped layer of arc-proofing tape shall then be applied over the full exposed length of the three (3) cable bundle. The arc-proofing tape shall extend into the duct/raceway, on both sides of the junction box, handhole or manhole, at least 1.5 inches. Tape shall be wrapped as tightly as possible to obtain a snug, wrinkle-free wrap which conforms to the cable and splice. Additional overlapping shall be applied wherever required, such as on curved sections of the cable and around projections. Overlap the last 6 inches of protected cable when starting a new roll of tape.

G. The arc-proofing tape is not adhesive coated and shall be held in place after wrapping by banding the first and last applied wrap of arc-proofing tape with two (2) complete wraps of adhesive glass cloth tape. Do not spiral wrap or random reverse wrap the glass cloth tape over the arc-proofing tape as this will interfere with the foaming (intumescent) protective action of the arc-proofing tape which will expand in the event of a fire within

the junction box, handhole or manhole to provide an insulating firewall between the flames and cables.

H. Do not arc-proof individual medium-voltage cables inside equipment.

3.4 MEDIUM-VOLTAGE POWER CABLE IDENTIFICATION

A. Identify cables in accordance with Section 260553 – Identification for Electrical Systems.

3.5 MEDIUM-VOLTAGE CABLE TESTING

A. Prior to installation measure conductor resistance and shield resistance on each shipping length of cable and record. Test at room temperature per manufacturer requirements. Measure insulation resistance and provide insulation resistance constant not less than 20,000 at 60°C.

B. *Preparation*: Perform the following preparations in advance of DC HiPot testing.

1. Test cables' insulation resistance
2. Test circuits' continuity
3. Make power available at test locations

C. Schedule tests and notify the Construction Representative at least one week in advance of schedule for test commencement.

D. Submit results of all preparatory testing to Designer indicating date of testing, name(s) and employer of individual(s) performing the testing, test equipment used for the testing including make, model, serial number and calibration date.

E. Test procedure shall conform to the following:

1. *Test Objectives*: To assure cable installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
2. *Procedures*: Comply with IEEE 48 and IEEE 400. Upon completion of tests, attach a label to tested components.

F. All medium-voltage cables shall be given a direct current high potential (DC HiPot) test by an independent cable acceptance testing firm, approved by the Designer, after the cable has been pulled into the raceway and all splices and terminations have been made but before the shrink tubing has been installed. Cables shall be disconnected from the end termination equipment during testing. Lightning (surge) arrestors and surge capacitors, if used, must be disconnected during testing.

G. Acceptable independent cable acceptance testing firms:

1. ABB
   Kansas City, KS
   (913) 286-8028
   Roger Andrews
2. Eaton Engineering Services and Systems (EESS)
   62 Soccer Park Rd.
   Fenton, MO 63026

(636) 734-2316
Kyle Crangle

3. Electric Power Systems, Inc.
21 Millpark Ct.
Maryland Heights, MO 63043
(314) 807-2682
Shawn Allen

4. Schneider Electric Services
St. Louis, MO
(314) 437-6987
Andrea Wolfe

H. All medium-voltage cables shall be tested in accordance with the cable manufacturer's recommendations.

I. Cable continuity and phase identification shall be checked.

J. Each conductor shall be given a full dielectric absorption test with a 5,000-volt motor driven megger prior to the high potential test. The test shall be applied to fully charge the conductor. Megger readings shall be taken every 15 seconds during the first three minutes and at one minute intervals thereafter until three equal readings one minute apart are obtained. The cable may then be considered fully charged. The minimum megger reading shall be 200 megohms.

K. Direct current high potential tests shall be used to determine the suitability of the cable for use. The maximum DC voltage to be used for testing shall be 55,000 volts for new 15 kV cable and 30,000 volts for existing 15 kV cable.

L. The test voltage shall be applied gradually in 5 kV increments until the final value of test voltage is reached. Additional steps may be done if required by the testing firm.

M. Voltage shall be held at each step until the leakage current stabilizes. Maximum test voltage shall be held for 15 minutes for new cables and 10 minutes for existing cables.

N. Where new cables are spliced to existing cables the entire spliced cable shall be tested as an existing cable at 30,000 VDC held for 10 minutes.

O. The values of leakage current versus voltage shall be plotted on 8-1/2 inch x 11-inch graph paper as the test progresses in order to keep a check on the condition of the cable. As long as this curve stabilizes and is relatively flat (equal increments of voltage giving equal increments of current) the cable under test may be considered to be in good condition for acceptance. At some point the current may start rising at a more rapid rate and may show up on the plot as a knee in the curve. If this point on the curve is obtained at a point considerably below the maximum test voltage, the test shall be stopped and the Contractor shall await further instructions from the Designer or Construction Representative.

P. When the maximum test voltage is reached, it shall be left on and the leakage current shall be plotted versus time at 15-second intervals for one minute and then at one-minute intervals until the initial high charging value reaches a steady state value, normally within 3-5 minutes. Maximum test voltage shall be held for 15 minutes. Any subsequent increase in current during this test is indicative of a bad cable or equipment and the test should be stopped and await further instructions from the Designer or Construction Representative.

Q. After the current has stabilized and the last reading is taken, the equipment should be turned off. The voltage on all three phases shall be recorded after one-minute discharge time. The voltage discharge time down to 3 kV shall be recorded. With the voltage at zero, the cable shall be connected to ground and then disconnected from the test equipment.

R. Each cable shall be tested between one conductor and ground with the other two conductors, metallic shielding and the metal sheath connected to ground.

S. The test record shall include cable identification, date, voltage versus leakage current graph, leaking current versus time graph, measured temperature and humidity at test location, operator and firm who performed tests, and one-line diagram of the cable tested. One-line diagram shall include cable lengths, splices, terminations, etc., with the location and type of installation indicated.

T. All test results shall be certified and submitted to and approved by the Designer prior to energization of any cables or on the first business day after completion of the testing if the testing is performed at a time other than normal weekday business hours.

U. After successful completion of the total circuit DC HiPot testing, including discharging the cables as specified herein, the shrink tubing shall be applied at all terminations, the cables terminated, shields grounded at the terminations, and in-line splices arc-proof taped as specified herein.

END OF SECTION 260513

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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 SCOPE

A. The Contractor shall furnish and install all conductors, wiring, and cables as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260526 – Grounding and Bonding for Electrical Systems

C. Section 260533.13 – Conduit for Electrical Systems

D. Section 260533.16 – Boxes for Electrical Systems

E. Section 260553 – Identification for Electrical Systems

F. Section 260583 – Wiring Connections

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each of the following items:

1. 1000-volt building wire
2. 600-volt building wire
3. 600-volt multiconductor control cable
4. 600-volt shielded instrumentation cable
5. CAT 6 copper Ethernet cable

B. Submit test report indicating results for copper wire and cable continuity and resistance testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. All cable and wire shall have copper conductors; aluminum shall not be substituted nor permitted.

B. All conductors shall be new, shall be approved and listed by Underwriters' Laboratories, Inc., (UL), shall bear UL identification, and shall have been manufactured within six months from date of the Contract. If requested by the Designer, the Contractor shall supply authenticated data from the wire manufacturer stating the manufacturing date of the wire.

C. All wire sizes are expressed in American Wire Gauge (AWG) or in circular mils. Unless otherwise indicated, all conductors shall have 90ºC rated insulation (wet or dry). The current rating of all conductor sizes shall be calculated using the correction factors and ambient temperature adjustment factors in NEC Article 310-15(B) but under no circumstance shall exceed the values listed in the 60°C temperature column of the tables for circuits 100 amps and below or the 75°C temperature column for circuits over 100 amps.

D. Conductors for all branch circuits and feeders shall be color coded in accordance with the National Electrical Code (NEC) and correctly phased throughout the electrical system.

2.2 1000-VOLT BUILDING WIRE

A. All conductors for 480-volt, ungrounded power systems, including equipment grounding conductors, shall be copper, 1000-volt, single conductor building wire:

1. Conductor: ASTM B3 and ASTM B8; stranded annealed copper, size 12 AWG minimum.
2. Insulation: 600-volt, Flame Retardant, thermoset Cross-linked Polyethylene (XLPE) per ICEA S-95-658/NEMA WC70 Section 3; thickness per UL 44 and ICEA S-98-658/WC70, Table 3-4, Column B
3. Temperature Rating, Continuous Use: 90°C wet or dry locations
4. UL Listed: Type XHHW-2 or RHW-2
5. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-95-658/NEMA WC70 and IEEE 383.
6. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-95-658/NEMA WC70 and IEEE 383.
7. Flame Test Certification: UL 1581, VW-1 in all sizes and passes IEEE 383 ribbon burner flame test in sizes 1/0 AWG and larger
8. Identification: Surface printing on the cable shall show manufacturer's name, conductor size and metal, voltage rating, UL symbol, insulation type and color per NEC Article 310-110 – Conductor Identification and Section 260553 – Identification for Electrical Systems.
9. Manufacturer: Priority Wire & Cable, Okonite, Service Wire Company or approved equal

2.3 600-VOLT BUILDING WIRE

A. All conductors for 120/208 and 120/240-volt power systems, including equipment grounding conductors and single conductor control wiring, shall be copper, 600-volt, single conductor building wire:.

1. Conductor: ASTM B3, annealed copper. Conductor sizes 12 and 10 AWG shall be solid, 8 AWG and larger and 14 AWG single conductor control wiring shall be stranded per ASTM B8. Minimum conductor size shall be 12 AWG except for single conductor control wiring which shall be 14 AWG.
2. Insulation: 600-volt, Flame Retardant, thermoset Cross-linked Polyethylene (XLPE) per ICEA S-95-658/NEMA WC70 Section 3; thickness per UL 44 and ICEA S-98-658/WC70, Table 3-4, Column B
3. Temperature Rating, Continuous Use: 90°C wet or dry locations

4. UL Listed: Type XHHW-2

5. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-95-658/NEMA WC70.

6. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-95-658/NEMA WC70.

7. Identification: Surface printing on the cable shall show manufacturer's name, conductor size and metal, voltage rating, UL symbol, insulation type and color per NEC Article 310-110 – Conductor Identification and Section 260553 – Identification for Electrical Systems.

8. Manufacturer: Priority Wire & Cable, Okonite, Service Wire Company or approved equal

B. Leads to special equipment shall be as recommended or supplied by the fixture or equipment manufacturer and as shown on the Drawings or as required by applicable codes.

2.4 600-VOLT MULTI-CONDUCTOR CONTROL CABLE

A. All low voltage control cable shall be copper, 600-volt, unshielded, multi-conductor control cable conforming to ICEA S-73-532/NEMA WC57.

1. Conductors: ASTM B33 and B8; Class B stranded annealed copper conforming to ICEA S-73-532/NEMA WC57. Size 18 AWG, 16 AWG or 14 AWG as indicated on the Drawings. Where no size is indicated use size 14 AWG.

2. Insulation: 600-volt, Flame Retardant, Ethylene Polyethylene Rubber (FR-EPR) Type II per ICEA S-73-532/NEMA WC57; thickness 25 mils per ICEA S-73-532/NEMA WC57, Table 3-1 or flame-retardant cross-linked polyethylene (XLPE) per ICEA S-73-532/NEMA WC57, thickness 30 mils per ICEA S-73-532/NEMA WC57, Table 3-1. Color coding shall be ICEA Method 1, E-2. Where wire colors white and/or green are required, color coding shall be ICEA Method 1, E-1.

3. Jacket: Lead-free, Cross-linked Chlorinated Polyethylene (XL-CPE) with thickness per UL 1277 and ICEA S-73-532/NEMA WC57, Table 4-1 as follows:

   a. 14 AWG, 2 to 7 conductors: 45 mils

   b. 14 AWG, 9 to 19 conductors: 60 mils

   c. 16 AWG, 2 to 4 conductors: 45 mils

   d. 16 AWG, 5 to 12 conductors: 60 mils

   e. 16 AWG, 15 to 19 conductors: 80 mils

   f. 18 AWG, 2 to 12 conductors: 45 mils

   g. 18 AWG, 15 to 19 conductors: 60 mils

4. Temperature Rating: Cable shall be suitable for continuous use at 90°C wet or dry (ICEA S-73-532/NEMA WC57, Section 3, Paragraph 3.4.1).

5. UL Listed: Type TC Power and Control Tray Cable per UL 1277

6. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

7. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

8. Flame Test Certification: Passes IEEE-383 ribbon burner flame test

9. Identification: Surface printing on the cable shall show the manufacturer's name, number and size of conductors, voltage rating, UL information, insulation type, jacket type, and numbered footage markers.

10. Manufacturer: General Cable Type CHTC, or approved equal by Basic Wire and Cable, Belden, Dekoron or Okonite

2.5 600-VOLT SHIELDED INSTRUMENTATION CABLE

A. Shielded instrumentation cable with shielded twisted pairs shall be 600-volt rated conforming to ICEA S-73-532/NEMA WC57.

1. Conductors: ASTM B33 AND B8; Class B stranded coated annealed copper conforming to ICEA S-73-532/NEMA WC57, size 18 AWG or 16 AWG as indicated on the Drawings. Where no size is indicated use size 16 AWG.

2. Insulation: 600-volt, flame retardant, cross-linked, polyethylene (XLPE) per ICEA S-73-532/NEMA WC57; thickness: 25 mils per ICEA S-73-532/NEMA WC57 Table 3-1. Color coding shall be by Method 1 per ICEA S-73-532/WC57 Appendix E using color-pigmented compounds. Each pair shall have one (1) white and one (1) black conductor. When multiple pairs are used, group identification shall be by printed numbers on one conductor of each pair in consecutive order.

3. Pair Shield: Aluminized Mylar or aluminized polyester tape in contact with a tinned copper drain wire. Shields to be isolated from all other assemblies.

4. Cable Shield: Aluminized Mylar or aluminized polyester tape in contact with a tinned copper drain wire

5. Jacket: Lead-free, cross-linked, chlorinated polyethylene (XL-CPE) per ICEA S-73-532/NEMA WC57 Section 4, Paragraph 4.2 with thickness per ICEA S-73-532/NEMA WC57, Table 4-1

6. Identification: Surface printing on the cable shall show the manufacturer's name, insulation type, jacket type, number of pairs, size of conductors, voltage rating, and numbered footage markers.

7. Temperature Rating: Cable shall be suitable for continuous use at 90°C wet or dry (ICEA S-73-532/NEMA WC57, Section 3, Paragraph 3.4.1)

8. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

9. Certification: All cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57 and IEEE 383.

10. Manufacturer: General Cable Company Type CHTC or approved equal by Basic Wire and Cable, Belden, Dekoron or Okonite

2.6 CAT 6 COPPER ETHERNET CABLE

A. 300-volt, CAT 6 (350MHz), 4-pair, U/UTP-Unshielded, indoor/outdoor, premise horizontal Ethernet cable conforming to NEC/UL Specification CMR, CMX-Outdoor.

B. Conductors: Solid bare copper size 23 AWG

C. Insulation: 300-volt, polyolefin (PO); minimum thickness: 0.00825", nominal thickness 0.008875". Color coding shall be:

1. Pair 1: White/blue strip and blue
2. Pair 2: White/orange strip and orange
3. Pair 3: White/green strip and green
4. Pair 4: White/brown strip and brown

D. Jacket: Lead-free, flame-retardant, sunlight resistant polyvinyl chloride (PVC); minimum thickness 0.023", nominal thickness 0.03".

E. Temperature Range: -40°C to +75°C

F. Electrical Characteristics:

1. Nominal Mutual Capacitance: 17 pF/ft
2. Maximum Capacitance Unbalance: 330 pF/100m
3. Nominal Velocity of Propagation: 68%
4. Maximum Delay: 537.6ns/100m @ 100MHz
5. Maximum Delay Skew: 35ns/100m
6. Maximum Conductor DC Resistance: 7.8 Ω/100m @ 20°C
7. Maximum DC Resistance Unbalanced: 3% @ 20°C

G. UL Listed: Type CMG, CMR, CMX-Outdoor

H. Testing: All cables shall be tested in accordance with UL 1666 Riser Flame Test and CSA Flame Test FT4.

I. Manufacturer: Belden 2146A or approved by Basic Wire and Cable or Dekoron

2.7 600-VOLT CONNECTIONS AND TERMINATIONS

A. Provide connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections.

2.8 CABLE PULLING LUBRICANT

A. Cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL Listed. The lubricant shall contain no greases, silicones, or polyalkylene glycol oils or waxes.

B. A 200-gram sample of the lubricant, when placed in a one-foot, split metal conduit and fully dried for 24 hours at 105°C, shall not spread a flame more than three inches beyond a point of ignition at a continued heat flux of 40 KW/M^2. Total time of test shall be one-half hour.

C. Cable pulling lubricant shall meet the following minimum specifications:

1. Lubricity at 200 lbs/ft Normal Pressure:
   a. PVC or XLP jacketed cable/PVC conduit

Coefficient of dynamic friction…….≤ 0.15

b. PVC or XLP jacketed cable/HDPE duct
Coefficient of dynamic friction…….≤ 0.15

2. Percent Non-Volitle Solids……...≤ 5.5%

3. Temperature Use Range……..20°F to 110°F

4. pH…….≥ 6.5, ≤ 9.0

5. Flammability……..…..……No Flash Point

6. Polyethylene Stress Cracking…….....None/ASTM D1693

7. Temperature Stability:

a. < 10% change in Brookfield viscosity from 40°F to 100°F
No separation after five freeze/thaw cycles or 24-hour exposure at 120°F

D. Cable pulling lubricant shall be:

1. POLYWATER® J

2. 3M WL

3. Approved equal by Ideal

PART 3 - EXECUTION

3.1 GENERAL

A. Store all conductors and cable indoors, protected from moisture.

B. Provide homerun conductors of continuous length without joint or splice from overcurrent protective device to first load termination point.

C. Provide power feeder conductors of continuous length without joint or splice for their entire length.

D. Conductors shall be continuous from source to destination without splices or taps in conduit runs, except where indicated on the Drawings to compensate for voltage drop or where required to prevent excessive pulling tension or sidewall pressure on wire or cable. Submit all proposed splice locations to the Designer for approval prior to pulling wire and cable. Where permitted, splices shall be mechanically strong and have an insulation value equal to the wire or cable being spliced. All splices and taps shall be contained within NEC sized junction boxes meeting the requirements of Section 260533.16 – Boxes for Electrical Systems.

E. All conductors and cables shall be in a raceway (conduit, duct, etc.) approved by the Designer, unless otherwise indicated.

F. Install conductors and cable with adequate bending radius in accordance with the National Electrical Code and the conductor and cable manufacturer's recommendations:

1. Greater than six (6) times the conductor and cable outside diameter for 600-volt and below wire and cable.

G. Swab the inside of conduit and raceways to insure they are dry and clean before conductors or cables are pulled. Care shall be exercised in pulling to avoid damage to the conductors or

cables. Pull all conductors into a conduit at the same time. An approved type of wire pulling lubricant, UL Listed for the application, shall be used.

H. All conductors and cables shall be installed directly from reels or coils. Conductors and cables shall not be pulled along the ground or subjected to treatment that may cause abrasion or other damage to conductor and cable insulation.

I. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that do not damage the conductor, cable or raceway.

J. All conductors and cables shall be installed as recommended by the manufacturer. The manufacturer's recommended maximum pulling tension and minimum bending radius shall be adhered to during installation. Utilize the necessary guides, pulleys, sleeves, and pulling aids to prevent abrasion and damage to the conductors or cables during installation. Monitor pulling tensions and associated sidewall pressures to prevent damage to conductors and cables.

K. Provide individual dedicated full size neutral for each and every 120V branch circuit.

L. Neatly train and lace wiring inside boxes, panelboards, switchboards and motor control centers. Group and tie single conductors of a circuit together at a minimum of 2-foot intervals. Provide supplemental structural members and materials as required to support wire and cable without transmitting strain to connection points.

M. Remove and discard conductors and cables cut too short or installed in wrong raceway. Do not install conductors or cables which have been removed from a raceway.

N. Do not install conductors or cables in conduit which contains wiring already in place.

O. Do not exceed NEC limits on conduit fill.

P. Conductors terminating in outlet or device boxes shall have at least 8 inches of free conductor left inside the box.

Q. Conductors for power shall not be smaller than size 12 AWG except wire supplied with equipment by the equipment manufacturer. Conductors for control wiring shall not be smaller than size 14 AWG unless otherwise indicated.

R. Leads to special equipment shall be as recommended or supplied by the equipment manufacturer and as shown on the Drawings or as required by the applicable codes.

3.2 WIRING SEGREGATION

A. Conductors with a voltage of more than 150V to ground shall not be installed in the same conduit with conductors with a voltage of less than 150V to ground.

B. Isolate and segregate power wiring circuits from control and instrumentation wiring circuits in conduit runs, boxes, panels, and equipment.

C. Isolate and segregate "normal" power circuits from "emergency" power circuits in conduit runs, boxes, panels, and equipment.

D. Isolate and segregate lighting and convenience receptacle wiring circuits from power, control, and instrumentation wiring in conduit and boxes.

E. Isolate control wiring circuits from instrumentation wiring circuits in conduit runs and boxes.

F. In boxes, provide isolation and segregation by rigid conduit chase through box interior or continuous metal dividers of same material as the box.

3.3 ETHERNET CABLE INSTALLATION

A. Conceal cables in finished spaces in buildings inside walls and above accessible ceilings.

B. Comply with ANSI/TIA-568.C.1.

C. Terminate all conductors. No cable shall contain unterminated elements. Make terminations only at cable connection points at equipment. Pairs shall not be untwisted more than 0.5 inches when terminating.

D. Cable placement shall conform to industry standards with regard to anchoring, cable support and separation from other facilities.

1. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames and terminals.
2. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
4. Cables shall not sag or droop but shall be installed so as to maintain a flat plane with smooth transitions from one level or direction to another.

E. Where cable is installed above suspended ceilings without cable tray or conduit, support cables by J-hook, cable hook, or cable hanger system spaced a maximum of 5 feet apart. Plastic cable ties or bridle rings shall not be used.

1. Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
2. Cables shall not be attached to or supported from fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.

F. Install cable without damaging conductors or cable jacket.

1. Do not install bruised, kinked, scored, deformed, or abraded cable.
2. Remove and discard cable if damaged during installation and replace with new cable.

G. Cables shall not be spliced. Do not splice cable between termination, tap, or junction points.

H. Bring cable to a minimum of 60˚F before de-reeling. Heat lamps shall not be used for warming cable.

I. Provide additional slack at both ends of cables to accommodate future cabling system changes.

1. Do not store slack in bundled loops. Slack shall be stored in fixture-8 configuration in an extended loop. Store slack above lay-in ceiling where possible.

2. In communications equipment room, install 10-foot long service loop on each end of cable.

3. Leave a minimum of 24-inch slack on each cable at each equipment panel.

J. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturer.

K. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

L. Contractor shall be responsible for verifying the actual footages and distances identified on the Drawings.

M. Install components as indicated and according to the manufacturer's written instructions. Use techniques, practices and methods that are consistent with the requirements of the Category rating of the components.

N. Provide minimum separation of cables from EMI sources in accordance with the cable manufacturer's recommendations.

O. Test and verity cable installation after terminating at both ends in accordance with industry standards and the manufacturer's recommendations for the Category rating of the components.

P. *CAT 6 Ethernet Cable Installation*: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

1. Comply with ANSI/TIA-568-C.2.

2. Do not untwist cables more than 0.5 inches from the point of termination to maintain cable geometry.

3. Test and verify cable installation after terminating at both ends in accordance with industry standards and the manufacturer's recommendations for the Category rating of the components.

3.4 WIRING CONNECTIONS AND TERMINATIONS

A. Provide connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections.

3.5 FIELD QUALITY CONTROL

A. General:

1. Testing shall be performed in the presence of Construction Representative. Contractor must provide 48 hours' notice prior to conducting tests.

2. Prepare a test report upon completion of testing activities. Report format shall include the following information:

a. Summary of test results

b. Test equipment summary (model number, accuracy, calibration date)

c. Test personnel names and sign-offs

d. Completed data sheets

e. Test log and observations

f. Certificate of Compliance

B. Inspect wire and cable for physical damage and proper connection.

C. Verify that all power conductors are properly phased throughout the electrical system.

D. Torque test conductor connections and terminations to manufacturer's recommended values.

E. Perform continuity tests.

F. Perform and record results of megger tests for each phase and neutral conductor for each feeder. Include actual recorded megaohm value for each conductor of each feeder in the feeder conductor insulation test report.

G. Provide testing for connections and terminations for 600-volt wire and cable in accordance with Section 260583 – Wiring Connections in conjunction with the testing specified herein.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 SCOPE

A. The Contractor shall furnish, install and test the grounding systems as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260533.13 – Conduit for Electrical Systems

D. Section 260533.16 – Boxes for Electrical Systems

E. Section 260583 – Wiring Connections

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Grounding conductors
2. Exothermic welds
3. Grounding clamps
4. Grounding connectors
5. Grounding lugs
6. Grounding rods

B. Grounding rod resistance test report.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. All grounding conductors shall be insulated, stranded copper, and unless otherwise indicated, shall meet the same specifications, in accordance with Section 260519 – Low-Voltage Electrical Power Conductors and Cables, as the accompanying circuit conductors.

B. Aluminum shall not be substituted for copper in grounding conductors.

2.2 EXOTHERMIC WELDS

A. Grounding wire connections to building steel or grounding rods shall be welded using an exothermic process, unless otherwise indicated. Approved exothermic processes shall be either:

1. Cadweld
   Manufactured by Erico Products, Inc.; Cleveland, Ohio
2. Harger
   Grayslake, Illinois
3. Thermoweld
   Manufactured by Continental Industries, Inc.; Tulsa, Oklahoma

B. Where welded electrical connections are referred to elsewhere in the Drawings or Specifications as being "cadwelded," it shall be understood that the process shall be exothermic by means of one of the above three manufactured methods.

2.3 GROUNDING CONNECTORS

A. Grounding conductor connections to equipment frames, equipment enclosures, and equipment ground lugs shall be made using corrosion resistant compression, bolted, or split-bolt connections. Bolts for equipment ground lugs shall be copper alloy terminal with a twin clamping element. Bolts for equipment enclosures shall be silicon bronze with lock washers.

B. Split-bolt connectors shall be copper and shall be UL Listed for connection of two (2) conductors within a listed range for each connector catalog number and the tap and run conductors shall not be required to be the same size.

C. Connectors for splicing grounding electrode conductors must be UL listed for such use and must be irreversible type. Mechanical type connectors are not acceptable for splicing grounding electrode conductors.

D. Grounding lugs used for termination of equipment grounding conductors installed with feeders and branch circuits shall be the same type of lugs as specified for the phase and neutral conductors per Specification Section 260583 – Wiring Connections. Provide grounding lugs that are UL listed for grounding, such as Burndy Type GKA, KPB, CL50-1 or CL or approved equals by one of the manufacturers indicated below, for bonding jumper and grounding conductor connections to equipment frames, equipment enclosures, conduit hub locknuts and grounding type conduit bushings.

E. Provide products by Blackburn, Burndy Corp., O-Z/Gedney, Penn-Union or approved equal.

2.4 GROUNDING RODS

A. Grounding rods shall be 3/4-inch diameter, 10 feet long (unless indicated otherwise on the Drawings), high strength solid steel rod with a bonded copper jacket, and UL listed.

B. Grounding rods shall be manufactured by Copperweld Steel Company, ITT Weaver; Thomas & Betts; Blackburn; Joslyn Mfg. and Supply Co.; or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The entire electrical system and all electrical equipment shall be grounded in strict accordance with Article 250 of the National Electrical Code and as shown on the Drawings.

B. The grounding system shall be continuous throughout the electrical system.

C. Insulated grounding conductors shall be identified with green colored insulation or marking tape in accordance with Section 260553 – Identification for Electrical Systems and NEC Article 250-119.

D. Grounding conductors shall be continuous with no splices.

E. Protect grounding conductors against unraveling, caging, and abrasion by several wrappings of plastic tape on all ends, where cable leaves concrete, and at necessary intermediate points.

F. Suitably protect grounding conductors against damage during construction. Replace or suitably repair at the discretion of the Engineer or Construction Representative if cable is damaged by anyone before final acceptance.

G. Install individual grounding conductors so as not to be entirely encircled, or closely encircled, by magnetic material unless it is properly bonded as specified herein.

H. When a conduit, which is fabricated of magnetic materials (e.g., steel conduit), contains only grounding conductors, the grounding conductors shall be bonded to the conduit at both ends of the conduit run, using grounding bushings with an NEC Article 250 sized bonding jumper installed between each grounding conductor and the bushing.

I. All neutral conductors shall be continuous throughout the electrical system.

J. Power system neutrals shall be grounded only at the service entrance equipment and at the transformer or generator where each system neutral is derived in accordance with NEC Article 250.

K. All metallic conduits shall be properly bonded and grounded.

L. All flexible conduits shall contain a properly connected green insulated copper grounding conductor, sized in accordance with NEC Article 250, unless otherwise indicated.

M. Flexible conduits 1-1/2" size and larger shall have an insulated stranded copper grounding conductor sized per the NEC installed external to the conduit and bonded to grounding type conduit connectors on each end of the conduit. The grounding conductor shall be secured to the conduit using nylon cable ties at 12" intervals. Cut off excess cable tie. Do not leave sharp edges.

N. A properly sized green insulated copper equipment grounding conductor shall be installed in each and every conduit.

O. The grounding pole of all receptacles shall be electrically bonded to the conduit system.

P. All flexible cords shall contain an insulated grounding conductor, color coded green, which shall be properly connected at each termination.

Q. All electrical equipment enclosures, control panels, boxes, conduits, equipment frames and other non-current-carrying metallic objects shall be grounded and bonded as required by the NEC.

R. *Connections:* All grounding conductor connections shall be made in accordance with the manufacturer's written instructions. Chemically degrease and dry completely before exothermically welding. Make up bolted connections clean and tight. All connections shall be low resistance with a resistance drop of less than 1 ohm. Do not cover connections until they have been inspected by the Designer or Construction Representative.

S. Grounding conductors and bonding jumper connection devices or fittings that depend on solder shall not be used.

T. Split-bolt type connectors are only UL Listed for the connection of two (2) conductors. Main and tap conductor sizes shall be in accordance with the UL listing as indicated by the manufacturer. Connections of more than two (2) grounding conductors require the use of a different type of UL Listed connector in accordance with Specification Section 260583 – Wiring Connections.

U. Bond all metal conduits to the ground bus bar conductor of the control panel, terminal box, panelboard, switchboard, switchgear, disconnect safety switch, automatic transfer switch, generator or frame of the equipment to which they are connected by terminating each conduit with a threaded steel insulated grounding bushing or an insulated throat, grounding type conduit hub having a solderless lug with a bonding jumper sized in accordance with NEC Table 250.66 or 102(C)(1) (as applicable) attached to the ground bus conductor or equipment frame. Where the enclosure does not contain a ground bus bar, bond to the enclosure using a compression or mechanical lug that is UL listed for grounding. Scrape away paint at grounding lug attachment location.

V. All control panel, panelboard, switchboard, switchgear and automatic transfer switch ground bus conductors, power transformer cases, all transformer neutrals, and all rotating electrical equipment shall be solidly and directly grounded to the nearest approved grounding point, or as shown on the Drawings, using a conductor sized in accordance with the NEC Table 250.66 or Table 102(C)(1) (as applicable) or as indicated on the Drawings.

W. Equipment grounds shall be made where indicated on the Drawings. Total resistance to ground shall not exceed five (5) ohms.

3.2 MOTOR GROUNDING

A. All motors rated 10 horsepower and below shall be grounded by an equipment grounding conductor, sized per the NEC, installed in the conduit with the power conductors that supply the motor.

3.3 METALLIC RACEWAY SYSTEM GROUNDING

A. Ground/bond metallic conduits at all termination points by means of a grounding type conduit bushing or conduit hub with grounding screw/lug on the locknut and a NEC sized insulated stranded copper bonding jumper.

B. Where extending metallic conduit into floor or grade mounted equipment from below, provide an insulated grounding bushing on the end of the conduit and bond to the equipment ground bus or frame using a NEC sized bonding jumper.

3.4 GROUNDING RODS

A. Driven grounding rods shall be installed in areas wherever required and where shown on the Drawings.

B. Unless otherwise indicated, grounding rods located outdoors shall be installed vertically with the top of the grounding rod 3 feet below finish grade.

C. Grounding conductor connections to grounding rods shall be exothermically welded.

3.5 GROUNDING ROD TESTING

A. The resistance to ground at all ground rod locations shall be tested by an independent testing firm, approved by the Designer, using an AVO Biddle DET 2/2 Ground Tester, Catalog No. 250202 or approved equal using the "Fall of Potential Method." The total resistance to ground shall not exceed five (5) ohms. If it does, the Contractor shall install additional ground rods and re-test until the resistance is below five (5) ohms.

B. Acceptable independent testing firms:

1. ABB Services
   Kansas City, KS
   (913) 286-8028
   Roger Andrews

2. Eaton Electrical Services and Systems (EESS)
   62 Soccer Park Rd.
   Fenton, MO 63026
   (636) 734-2316
   Kyle Crangle

3. Frank Sager & Son, Inc.
   4754 Theiss Road
   St. Louis, MO 63128-2349
   Mark Rodgers
   (314) 892-7550

4. Schneider Electric Services
   St. Louis, MO
   (314) 437-6987
   Andrea Wolfe

C. Provide written report of test results including date and time of testing, test equipment used, test equipment calibration date, and names of individuals performing the testing.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL EQUIPMENT

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 SCOPE

A. The Contractor shall furnish and install all supports and fastening devices for mounting and anchoring all raceways and electrical equipment as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260533.13 – Conduit for Electrical Systems

C. Section 260533.16 – Boxes for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Expansion anchors
2. U-channel steel supports including associated hardware and accessories
3. Seismic restraints

PART 2 - PRODUCTS

2.1 GENERAL

A. *Weld Rod:* Use E70 electrodes for shielded metal arc welding.

B. Provide materials, sizes, and types of supports, anchors, and fasteners to carry the loads of conduit, boxes, and equipment. Include weight of wire and cable when selecting products for conduit, equipment and box supports.

2.2 ANCHORS AND FASTENERS

A. Provide anchors and fasteners as required to install all conduit, boxes, electrical enclosures, and equipment.

B. *Expansion Anchors:* Utilize expansion anchors for attachment of electrical equipment, boxes and raceways to concrete and solid masonry surfaces.

1. Expansion anchors shall be stud type expansion anchor with a single-piece, three-section wedge, Hilti Kwik Bolt TZ2 or approved equal by Redhead or Powers Fasteners installed per the manufacturer's written recommendations. The anchors shall meet the description in Federal Specification FF-S-325, Group II, Type 4,

Class 1, for concrete expansion anchors and shall comply with ASTM 153. All bolts shall have length identification.

2. Indoors: Galvanized steel

3. Outdoors: Type 304 stainless steel

C. Provide adequate corrosion resistance for all fastening systems.

D. *Bolts and Nuts:* ANSI regular series, semi-finished, hexagon

1. Indoors: Cadmium plated or galvanized steel

2. Outdoors: Type 304 stainless steel

E. *Flat Washers:*

1. Indoors: Cadmium plated or galvanized steel

2. Outdoors: Type 304 stainless steel

F. *Lock Washers:* ANSI medium, spring type

1. Indoors: Cadmium plated or galvanized steel

2. Outdoors: Type 304 stainless steel

G. *Beam Clamps:* Steel beam and angle clamps by B-Line or Thompson

1. Indoors: Cadmium, zinc plated or hot-dipped galvanized

2. Outdoors: Type 304 stainless steel

H. *U-Bolts:* 1/4" minimum size

1. Indoors: Cadmium or zinc plated steel or hot-dipped galvanized steel

2. Outdoors: Type 304 stainless steel

2.3 STRUCTURAL SUPPORT SYSTEMS

A. *Steel Supports:* Brackets, frames and hangers shall be fabricated from standard cold rolled structural steel shapes or prefabricated structural systems, as manufactured by B-Line Systems, Inc., Unistrut Corporation, Kindorf Electrical Products Co., or approved equal.

1. Steel supports and accessories used indoors shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then electro-plated with zinc per ASTM B633. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).

2. Steel supports and accessories used outdoors or in indoor wet areas shall be Type 304 stainless steel.

3. Steel supports shall be 14-gauge or 12-gauge and either 1-5/8"x13/16" or 1-5/8"x1-5/8" as required based on equipment to be supported or as indicated on the Drawings.

B. *Hanger Supports:* Threaded rods

1. Indoors: Electro-galvanized steel

2. Outdoors: Type 304 stainless steel

2.4 THREADED ROD STIFFENERS FOR SEISMIC SUPPORTS

A. Stiffeners for treaded rods used for seismic support shall be B-Line SC228 or SC-UB or approved equal by Unistrut Corporation, Kindorf Electrical Products Co. or 12-gauge, 1-5/8”x1-5/8” U-channel per Paragraph 2.3 A for hanger rods longer than 12-inches.

PART 3 - EXECUTION

3.1 GENERAL

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to the approval of the Construction Representative.

B. Do not drill or cut any structural steel members.

C. Do not cut any structural concrete members.

D. Welding on any structure shall require prior written approval from the Construction Representative for each type of application except where specifically shown on the Drawings. Weld in accordance with AWS.

E. Do not use piping, ductwork, raceways, or equipment as structural members for support.

F. Equipment or raceways shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions unless specifically indicated on the Drawings.

G. A minimum of four (4) anchor points shall be provided for electrical equipment enclosures and dimensioned boxes.

H. Outdoor supports shall be installed to provide a minimum of 11/16” air space between wall mounted electrical equipment enclosures and mounting surface.

I. Provide corrosion resistant spacers, minimum 1/4”-thick, behind all equipment enclosures mounted on surfaces that are located in damp or wet locations such that the back of the enclosure is not in direct contact with the mounting surface.

3.2 ANCHORS AND FASTENERS

A. Unless noted otherwise on the Drawings, expansion anchor embedment shall be as follows:

1.

Bolt Diameter, in.	Embedment, in.
1/4	2
3/8	2-1/2
1/2	3-1/2
5/8	4
3/4	4-3/4

B. Anchor bolts for the new electrical equipment such as switchgear, neutral grounding resistor, panelboards, motor control center, medium-voltage generator connection cabinet and medium-voltage automatic transfer switch are to be the maximum diameter that will fit through the factory provided holes in the equipment base with minimum embedments

shown above in outdoor equipment pads and 6" minimum embedment for equipment installed on a concrete housekeeping pad on a concrete floor. Provide Belleville washers or square U-channel support washers per the equipment manufacturer's installation instructions for seismic restraint and where the enclosure bottom is sheet metal with no structural members.

C. Use factory installed external mounting tabs for mounting electrical equipment and electrical enclosures that are NEMA Type 3R, 4, 4X or 12. Drilling a mounting hole in any of these type enclosures will void its UL Listing and NEMA rating and will require that the enclosure be replaced at the Contractor's expense.

D. Utilize welded fasteners or beam clamps for attachment of electrical equipment and raceways to structural steel surfaces in accordance with the requirements of the Designer or Construction Representative. Weld in accordance with AWS.

E. Utilize toggle bolts, hollow wall fasteners or through-wall bolt fasteners for attachment of electrical equipment, boxes and raceways to hollow masonry surfaces.

F. Utilize stainless steel machine screws for attachment of electrical equipment, boxes and raceways to metal surfaces.

G. Nails shall not be used as a means of fastening.

H. Do not use spring steel clips.

I. Do not use powder-actuated anchors.

3.3 STRUCTURAL SUPPORT SYSTEMS

A. Weld in accordance with AWS.

B. Any galvanizing damaged by welding or erection shall be repaired with cold galvanizing per ASTM A780. Surface preparation shall include power disk sanding the abraded or welded area to bright metal.

C. Do not use chain.

D. Do not use perforated strap or wire.

3.4 SEISMIC BRACING

A. All electrical equipment shall be bolted down, and conduit shall be braced in accordance with the seismic design requirements of the International Building Code (latest adopted edition) utilizing the seismic loading factors in Section 260500 – Common Work Results for Electrical.

B. All floor mounted electrical equipment enclosures shall be properly and rigidly fastened to the floor in accordance with the equipment manufacturer's requirements.

C. Conduit trapeze hangers shall be stabilized both horizontally and vertically to prevent swaying or movement.

D. Provide stiffeners on all treaded rods used for seismic support as specified herein.

E. Transverse and longitudinal braces shall be no more than 45° above or below the centerline of the conduit.

F. When bracing trapeze type hangers, the bracing shall be attached directly to the trapeze hanger assembly, and the conduit shall be secured to the trapeze assembly with conduit straps.

G. Seismic bracing shall not limit the expansion and contraction of the conduit system.

H. The Contractor shall field locate bracing as required unless otherwise shown on the Drawings.

I. Seismic restraints may be omitted from the following installations:

1. All conduit suspended by individual hangers 12 inches or less in length from the top of the conduit to the bottom of the support for the hanger.
2. All electrical conduit less than 2-1/2 inches inside diameter.

J. Detailed design and installation of all electrical conduit supports and seismic restraints shall be the Contractor's responsibility.

K. Provide seismic-restraints complying with the requirements of applicable Building Codes, ASME Codes, NEC, and industry standards (e.g., MSS SP-58, Pipe Hangers and Supports and MSS SP-127, Bracing for Piping Systems: Seismic - Wind - Dynamic Design, Selection, And Application).

L. Seismic restraints are to be included in the submittal requirements for electrical supports and hangers.

END OF SECTION 260529

SECTION 260533.13 – CONDUIT FOR ELECTRICAL SYSTEMS

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 SCOPE

A. The Contractor shall furnish and install all raceways and fittings as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.16 – Boxes for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Each type of conduit (galvanized rigid steel, rigid aluminum, electrical metallic tubing, liquidtight flexible metallic, rigid non-metallic)
2. Conduit hubs
3. Internal conduit sealing bushings
4. External conduit sealing bushings
5. Conduit bodies
6. Conduit mounting clamps
7. Fire-stopping materials
8. Intumescent silicone sealant
9. Protective coating for direct buried metal conduit
10. Underground conduit warning tape
11. Conduit/duct plugs

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduit shall be new and shall be approved and listed by Underwriters' Laboratories, Inc. (UL) and shall bear the UL label of approval.

B. All conduit shall be one of the following:

1. Galvanized rigid steel conduit, “Heavywall” (GRC), shall be Schedule 40 steel conduit, hot dipped galvanized on both the outside and the inside. Conduit as obtained from the manufacturer shall have been cut and threaded before galvanizing, thereby insuring the galvanizing of these areas. Conduit shall conform to the latest editions ANSI Standard C80.1 and UL Standard No. 6 and shall meet the requirements of NEC Article 344.

    a. Minimum conduit size shall be 3/4-inch.

    b. Running threads are not permitted.

    c. GRC shall be used outdoors above grade down to 18” below grade and inside the Power Plant.

2. Rigid aluminum conduit (RAC), heavywall, copper-free threaded aluminum in accordance with ANSI C80.5 and shall meet the requirements of NEC Article 344.

    a. Minimum conduit size shall be 1-1/2-inch.

    b. Running threads are not permitted.

    c. Rigid aluminum conduit may be substituted for GRC in sizes 1-1/2” and larger except as follows:

        1) Rigid aluminum conduit shall not be installed on the roof of a building.

        2) Rigid aluminum conduit shall not be installed in poured concrete.

        3) Rigid aluminum conduit shall not be installed in locations or environments known to be corrosive to aluminum.

3. Electrical metallic tubing (EMT) shall be thin wall steel conduit, hot dipped galvanized on both the outside and the inside. EMT shall conform to ANSI Standard C80.3 and U.L. Standard 797 and shall meet the requirements of NEC Article 358.

    a. Minimum conduit size shall be 3/4-inch.

    b. All connectors and couplings shall be zinc plated steel. Die cast zinc type are not acceptable.

        1) Size 2-1/2” and smaller compression type

        2) Size 3” and larger set-screw type

    c. Connectors up to and including size 1-1/2” shall be insulated throat type. All connectors shall be terminated with a bonding type locknut. Threaded steel insulated grounding bushings having solderless lugs shall be used on connector sizes 1-1/4” and larger.

    d. EMT shall be used inside the Power Plant Control Room and Office.

4. Liquidtight flexible metal conduit (LFMC) shall be square locked galvanized steel flexible tubing having an extruded liquidtight thermoplastic or polyvinyl chloride (PVC) jacket, making the conduit moisture proof, oil proof, and sunlight resistant LFMC shall conform to U.L. Standard 360 and shall meet the requirements of NEC Article 350. Liquidtight flexible metal conduit shall be used at all locations where a flexible conduit connection is required.

   a. Minimum conduit size shall be 1/2-inch.

   b. Conduit and fittings shall be rated for 90°C conductors or cable and for use in direct sunlight.

   c. Liquidtight flexible metal conduit shall contain a continuous copper ground built into the core in sizes 1/2-inch through 1-1/4-inch, and all sizes shall be approved and listed by Underwriters' Laboratories, Inc. (UL). Liquidtight flexible metal conduit shall be rated for a minimum temperature range of -20°C (-4°F) to +60°C (+140°F), and shall be as manufactured by the following:

      1) Anamet, Inc., Type UA

      2) Electri-Flex Company, Type LA Liquatite

      3) Southwire/Alflex, Type UL Ultratite

   d. All connectors and couplings for liquidtight flexible metal conduit shall be malleable iron with hot-dipped galvanized or steel with zinc plated finish, compression ring, positive ground, positive grip, liquid tight, rain-tight and oil tight.

   e. All connectors and fittings shall be UL Listed as suitable for grounding in sizes 1/2-inch through 1-1/4-inch.

   f. All connectors shall be insulated throat type. All connectors shall be terminated with a bonding type locknut. Threaded steel insulated grounding bushings having solderless lugs shall be provided on connector sizes 1-1/4" and larger.

   g. All connectors in sizes 1-1/2-inch and larger shall have a grounding lug on the gland nut for connection of an external grounding conductor in accordance with Section 260526 - Grounding and Bonding for Electrical Systems.

   h. Neither flexible metal conduit ("greenfield") nor liquidtight flexible nonmetallic conduit shall be substituted for liquidtight flexible metal conduit.

   i. Unless otherwise indicated, liquidtight flexible metal conduit shall only be used for the final connection to:

      1) Vibrating type equipment, such as motors, HVAC equipment, and transformers (flexible connection not to exceed 3 feet).

      2) All remotely located control devices and instrumentation such as damper actuators, solenoid valves, position switches, limit switches, temperature transmitters, flow transmitters, etc. (flexible connection not to exceed 2 feet).

      3) As permitted elsewhere in these Specifications or Drawings.

5. Rigid non-metallic conduit shall be heavy wall Schedule 40 (NEMA EPC-40 PVC, Type II-III) polyvinyl chloride (PVC) electrical plastic conduit and shall meet the

requirements of NEC Article 352. Rigid non-metallic conduit shall be as manufactured by Carlon Electrical Products; Condux International, Inc.; Can-Tex Industries; Certainteed Products Corp.; or approved equal.

a. Minimum conduit size shall be 1-inch.

b. Rigid non-metallic conduit (PVC) shall only be used below grade.

c. Adhesive for PVC conduit shall be as recommended by the manufacturer of the PVC conduit

2.2 CONDUIT HUBS

A. Conduit hubs shall be grounding type, insulated throat, liquid-tight:

1. Zinc plated steel or malleable iron for terminating rigid galvanized steel conduit in painted steel NEMA 12 electrical equipment enclosures and in painted steel or galvanized steel junction and pull boxes and wireways

2. "Copper free" aluminum for terminating rigid aluminum conduit in painted steel NEMA 12 electrical equipment enclosures and in painted steel or galvanized steel junction and pull boxes and wireways

3. Type 304 or 316 stainless steel for terminating rigid galvanized steel conduit at stainless steel electrical equipment enclosures, junction and pull boxes and wireways

B. Provide with a ground lug/screw on the lock nut.

C. Conduit hubs shall be Myers Type STG, STAG or SSTG Scru-Tite or approved equal by Eaton Crouse-Hinds or Appleton Electric.

D. Provide Fluoramics LOX-8, or approved equal, anti-corrosion thread sealant at threaded galvanized rigid steel conduit connections to stainless steel conduit hubs for compliance with NEC 344.14.

2.3 CONDUIT SEALING BUSHINGS

A. *Internal Conduit Sealing Bushings:* Designed to seal around the conductors/cables inside a conduit and shall have a one-piece, neoprene ring between two (2) PVC coated steel discs that are custom drilled at the factory to accommodate the conductors contained in the conduit and are held together by stainless steel socket or hex head screws with stainless steel washers. Conductor holes in the PVC coated steel rings shall be slotted to eliminate inductive heating.

B. Internal conduit sealing bushings shall be designed for installation inside the end of a rigid metal conduit and shall be O-Z/Gedney Type CSBI (non-segmented type), or approved equal.

C. *External Conduit Sealing Bushings:* Designed to seal around the outside of a conduit at concrete or masonry wall penetrations and shall be O-Z/Gedney Type CSM, or an interlocking EDPM rubber link assembly, with stainless steel bolts and nuts, Link-Seal Model S-316 by Pipeline Seal and Insulator, Inc., or approved equal

2.4 CONDUIT PENETRATION SEALING ASSEMBLIES

A. *Environmental Conduit Penetration Sealing Assemblies:* Use to seal around conduit penetrations between interior temperature controlled and non-temperature controlled spaces and between above grade indoor and outdoor areas.

B. Sealing assembly shall be modular, mechanical type, consisting of inter-locking synthetic EPDM (black) rubber seal elements shaped to continuously fill the annular space between the conduit and the wall or floor opening. The elastomeric element shall be sized and selected per manufacturer's recommendations with a temperature range of -40°F to +250°F.

C. Pressure plates and bolting shall be steel with 2-part zinc dichromate and organic coating or glass reinforced nylon.

D. *Fire Rated Conduit Penetration Sealing Assemblies:* Use to seal around conduit penetrations in fire rated construction**.**

E. Sealing assembly shall be modular, mechanical type, consisting of interlocking silicone (grey) rubber seal elements shaped to continuously fill the annular space between the conduit and the wall or floor opening. The elastomeric element shall be sized and selected per manufacturer's recommendations with a temperature range of -67°F to +400°F.

F. Pressure plates and bolting shall be steel with 2-part zinc dichromate.

G. Single Link Seal shall provide a Factory Mutual Approved 1 hour fire stop rating.

H. Provide double fire rated conduit seal consisting of two single fire conduit seals back-to-back with a tie rod that tightens both seals simultaneously to provide a Factory Mutual Approved 3-hour fire stop rating.

I. Conduit penetration sealing assembly shall be Link-Seal Model C by PSI Seal and Insulator, Inc., or Link Seal Catalog No. LSA by Cooper Crouse-Hinds or approved equal.

2.5 CONDUIT BODIES

A. Conduit bodies shall be provided as required or where indicated on the Drawings and shall be hot-dipped galvanized malleable iron with galvanized steel gasketed covers or cast, "copper-free" aluminum having threaded hubs and stainless steel or "copper-free" aluminum, neoprene gasketed covers fastened with stainless steel screws, rain-tight, suitable for wet locations, Crouse-Hinds, Appleton or O-Z Gedney Form 35, Form 8, Mark 9, or Mogul. Die-cast aluminum types are not acceptable.

B. Conduit body cover screws shall thread directly into the conduit body. Conduit body covers with wedge-clamp type covers are not acceptable.

C. Conduit body hub configuration shall be as required based on conduit routing for the cover to be readily accessible for easy removal.

D. Conduit bodies enclosing size 6 AWG or smaller conductors shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit to which the conduit body is attached.

E. The maximum number of conductors shall be computed in accordance with NEC Article 314-16(C).

2.6 CONDUIT MOUNTING CLAMPS

A. Conduit mounting clamps for securing conduits inside buildings shall be galvanized steel one-hole, two-hole or H-Type (mini's). Conduit mounting clamps used outdoors shall be Type 304 stainless steel.

B. Conduit mounting clamps for securing rigid metal conduits to concrete or masonry surfaces inside buildings shall be one piece "copper-free" aluminum or zinc plated malleable iron one hole type, Crouse-Hinds Cat. No. 5XX or approved equal with Crouse-Hinds Cat. No. CBX or approved equal "copper-free" aluminum or zinc plated malleable iron clamp backs/spacers.

C. Conduit mounting clamps for mounting conduits to channel supports shall be electro-plated zinc, hot-dipped galvanized steel after fabrication per ASTM A123 with minimum coating thickness of 2.5 mils, or Type 304 stainless steel to match channel support material, B-Line B2000 Series or approved equal by Unistrut Corporation or Kindorf Electrical Products, Co.

2.7 FIRE-STOPPING MATERIALS

A. The following fire-resistant penetration sealing materials are approved for use in indoor dry areas:

1. 3M Caulk CP 25
2. 3M Wrap/Strip FS-195
3. Damming materials – 3M Composite Sheet CS-195
4. SpecSeal Series 100 sealant
5. Rector Seal Corporation, Metacaulk 835 fire stopping sealant
6. Dow Corning 3-6548 silicone RTV foam
7. General Electric GE RTV850 or GE RTV6428
8. Chase Technology Corporation CTC PR-855 fire-resistant silicone foam

2.8 INTUMESCENT SILICONE SEALANT

A. Intumescent silicone sealant shall meet UL Water Leakage Test – Class 1 requirements and shall be re-enterable and repairable; 3M Fire Barrier Water Tight Silicone Sealant 3000WT or Designer approved equal.

B. Fire barrier packing material for use with 3M UL listed 3000WT intumescent silicone sealant shall be 6 psf mineral wool, 3M Fire Barrier Packing Material PM4 or Designer approved equal.

2.9 CONDUIT PULL STRING

A. Conduit pull string shall be Greenlee or equal with a minimum of 240 lbs. tensile strength, and shall be rot and mildew resistant. Pull string shall have permanently printed sequential measurements at one-foot increments.

2.10 PROTECTIVE COATING FOR DIRECT BURIED METAL CONDUIT

A. Protective coating for direct buried metallic conduit shall be Kop-Coat, Inc. Bitumastic No. 50 or two coats of 3M Scotchrap pipe primer over wrapped in accordance with the manufacturer's written instructions with 3M No. 51, 20 mil thick tape.

2.11 UNDERGROUND CONDUIT WARNING TAPE

A. Warning tape shall be fabricated from polyethylene film, and shall be 6 inches wide and not less than 3.5 mils thick.

B. Warning tape for all directly buried electrical conduit shall be high visibility red in color and imprinted at frequent intervals with black letters having the following wording:

CAUTION BURIED ELECTRIC LINE BELOW

C. Warning tapes shall be Terra-Tape "Extra Stretch" manufactured by Reef Industries, Inc., or approved equal, by EMED Co., Inc., Seton, W. H. Brady Co., or Allen Systems, Inc.

2.12 CONDUIT/DUCT PLUGS

A. Plugs for sealing empty duct bank conduits shall be compressible natural rubber with stainless steel plate on both sides with stainless steel bolt and stainless-steel wing nut or hex nut for compressing the rubber plug between the two stainless steel plates to secure it inside the conduit or duct or all plastic/rubber with no metal parts.

B. Conduit/duct plugs shall be T-Cone Plug by ETCO Specialty Products or Blank Duct Plug by Calam or approved equal by Osbourne Associates, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONDUIT

1. Verify routing and termination locations of conduit runs prior to rough-in.
2. Conduit routing shown on Drawings is approximate. Route as required to complete wiring.
3. Design, layout, and detail conduit runs to permit installation.
4. Coordinate conduit routing with the Construction Representative to avoid equipment operational and maintenance interferences and to permit easy removal of all conduit body and box covers.
5. Conduit or fittings having any type of defects shall not be used in the work.
6. Exposed conduit shall be run perpendicular or parallel to building walls. Where more than one conduit in a bank of exposed conduit changes direction, all bends shall be concentric.
7. The Contractor shall consult all the other trade drawings to ascertain where conflicts may occur and shall install all conduit as required to avoid conflicts.
8. Conduits shall be continuous from outlet to outlet, from outlet to junction or pull boxes, from source panel to equipment, and shall be terminated to all boxes and

enclosures in such a manner that the conduit system is mechanically and electrically continuous throughout the system.

9. The Contractor shall furnish and install NEC sized pull boxes or conduit bodies wherever necessary in order that a run of conduit between conductor/cable pulling points does not contain more than the equivalent of four quarter (90 degree) bends (360 degrees total).

10. Conduit bends shall not be less than the standard radius, unless otherwise indicated.

11. A minimum clearance of nine inches (9") shall be maintained between all conduits and pipes carrying steam, hot liquids, or hot gases, except at points of cross over, in which case the clearance may be reduced to six inches (6"). Any exceptions to this shall be presented to the Designer for approval on an individual case by case basis.

12. Maintain adequate clearance between conduit and piping, allowing for the maintenance of insulation and outer protective covering on piping.

13. Couplings for conduits in a group shall be staggered at least six (6) inches.

14. Conduit shall not be routed along floors.

15. Conduits shall be concealed in finished spaces and exposed in unfinished spaces.

16. In unfinished spaces, arrange conduit to maintain minimum 9’-0" headroom above floors, unless otherwise approved by the Construction Representative.

17. All rigid metal conduit, threaded joints and couplings shall be made up wrench tight with at least five full threads engaged. The use of running threads at conduit couplings and terminations is prohibited. All cut ends of conduits shall be reamed to remove rough edges and shall be free of burrs and sharp edges. An approved aluminum lubricant shall be used with rigid aluminum conduit.

18. Coat all field cut threads on rigid galvanized steel conduit with a conductive anti-corrosion surface compound such as Thomas & Betts KOPR-Shield except that for rigid galvanized steel conduit connections to stainless steel conduit hubs, apply Fluoramics LOX-8, or approved equal, anti-corrosion thread sealant to the threads for compliance with NEC 344.14.

19. Coat all scars or wrench abrasions in rigid galvanized steel conduit with an approved organic zinc rich primer equivalent to Koppers' "Organic Zinc."

20. Plastic or steel caps or bushing pennies shall be placed in the end of each conduit as soon as it is located to prevent filling with foreign materials, until the conductors are installed.

21. Unless otherwise indicated, the exposed ends of all spare conduits shall be threaded and closed with a screw cap.

22. Conduit shall be supported on approved types of steel brackets, channels, ceiling trapeze, pipe straps or hangers secured by means of toggle bolts, hollow wall fasteners or through wall bolt fasteners on hollow masonry or clay tile blocks; or expansion anchors in concrete or brick; or machine screws on metal surfaces; or wood screws on wood construction. Nails or powder-actuated anchors shall not be used as a means of fastening. Perforated flat steel straps or wire shall not be used for supporting conduit. All conduit shall be properly supported in accordance with Section 260529 – Hangers and Supports for Electrical Equipment in order to deter any possible vibration, noise or chatter.

23. Conduit shall be supported from building structures. Do not use piping, ductwork, other raceways or equipment for supporting conduits. Support all conduit runs at a minimum of every 9 feet and within 3 feet of all terminations.

24. Independently support conduits from building structure above acoustical panel lay-in ceilings. Do not fasten conduits to ceiling support wires.

25. Where possible, group conduits on U-channel conduit racks.

26. Utilize U-channel supports and associated fittings and hardware for conduit support in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

27. Terminate rigid metal conduits at all NEMA Type 1 junction and pull boxes and equipment enclosures inside buildings with a minimum of two (2) locknuts, one inside and one outside the enclosure, and a steel or malleable iron insulated throat, grounding bushing having a solderless lug and a copper bonding jumper, sized in accordance with NEC Article 250, to connect the conduit to the equipment grounding bus bar located inside the enclosure. Provide a grounding lug where the enclosure does not contain an equipment grounding bus bar.

28. Provide insulated throat, liquid tight, grounding type conduit hubs to terminate rigid metal conduits at all NEMA Type 3, 3R, 4, 4X, 12 and 13 enclosures without integral cast threaded hubs. Provide a copper bonding jumper, sized in accordance with NEC Article 250, to connect the conduit hub locknut to the equipment grounding bus bar located inside the enclosure. Provide a grounding lug where the enclosure does not contain an equipment grounding bus bar.

29. Conduits or raceways, including the end fittings, entering the bottom of a floor or grade mounted enclosure without legs, such as a panelboard, switchboard, motor control center, switchgear, automatic transfer switch, generator connection cabinet or transformer, shall terminate 2 inches above the bottom of the enclosure or top of concrete equipment pad on which the enclosure stands. If the conduit is rigid galvanized steel, provide an insulated grounding bushing on the end of the conduit and bond to the enclosure ground bus.

30. Grounding and bonding of conduit shall be in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.

31. Identify all conduit runs; both new conduit and existing that is reused, in accordance with Section 260553 – Identification for Electrical Systems.

32. Prior to installing any cables in any existing conduit that is to be reused, demonstrate to the Construction Representative that the conduit is clear of obstructions by pulling a mandrel 1/2-inch smaller than the nominal size of the conduit through the entire length of the conduit.

33. Provide a nylon or polypropylene pull string in all empty or "spare" underground conduits. Provide three feet of string inside the panelboard or junction box at each end of the conduit and tie off inside the enclosure.

B. CONDUIT SEALING BUSHINGS

1. Provide internal conduit sealing bushings at all electrical enclosures where a conduit is exposed to widely different temperatures, or where an underground conduit enters a building horizontally below grade to prevent condensation or moisture inside the conduit from entering the enclosure.

2. For conduit/conductor arrangements for which a factory drilled conduit sealing bushing is not available**,** seal the inside of the conduit, around the conductors or cables, at the first conduit body or enclosure inside each building using an intumescent silicone sealant.

3. Provide external conduit sealing bushings at all conduits entering a building through a concrete or masonry wall. Sealing devices shall be installed such that all bolts in the sealing bushing or link seal are accessible

4. Install an internal conduit sealing bushing in the end of a duct or conduit that enters the bottom of a grade mounted switchgear, generator connection cabinet or neutral grounding resister to seal around the conductors/cables and prevent vermin from entering the conduit. Do not seal around cables/conductors in conduits with expandable foam sealant or other non-approved sealing products.

C. CONDUIT BODIES

1. Conduit bodies shall be sized for the conductor fill of the conduits to which it is connected. Use Mogul type conduit bodies if/as required.

2. Conduit body sizing shall be based on the maximum number of conductors permitted accordance with NEC Article 314-16(C).

3. Conduit bodies enclosing size 6 AWG or smaller conductors shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit to which the conduit body is attached.

4. Conduit bodies shall not contain splices, taps, or devices.

5. Conduit bodies shall be supported in a rigid and secure manner.

D. CONDUIT MOUNTING CLAMPS

1. Conduit shall not be mounted in direct contact with any concrete or masonry wall or ceiling. Utilize U-channel supports or clamp backs/spacers to hold conduits a minimum of 3/16 inch away from concrete or masonry surfaces. Clamp backs/spacers shall be stackable to allow the conduit to be spaced further away from the mounting surface as required.

E. CONDUIT OPENINGS

1. Provide conduit openings in floors, walls, and ceilings as required to install conduit runs. Openings shall be kept to a minimum, as small as possible, and installed in a neat manner. All damage to existing surrounding surfaces when installing openings shall be repaired to original condition.

2. Locations of all openings shall be approved by the Construction Representative before beginning work.

3. Core drill all openings in existing concrete or masonry surfaces using a dustless method.

4. After installation of conduit, openings in interior concrete or masonry walls or ceilings shall be formed, grouted, and caulked to provide a moisture and fire barrier that is equivalent to the fire rating of the wall or floor.

5. All openings through which a conduit passes through interior walls, floors and ceilings shall be properly sealed after the conduit is installed to prevent transmission or leakage of liquids, dust, fire, smoke, or sound. Openings in non-fire rated concrete or masonry construction through which conduit passes shall be

sealed, after the conduit is installed, with material similar to that which surrounds the opening. Openings in fire-rated construction through which conduit passes shall be sealed, after the conduit is installed, with an APPROVED fire-resistant penetration seal. All fire-resistant penetration seals shall be installed in accordance with the manufacturer's instructions.

6. Provide conduit penetration sealing assembly for all openings in floors, walls, and ceilings between interior temperature controlled and non-temperature controlled areas and between indoor areas and above grade outdoor areas.

7. Exterior metal wall panel openings shall be cut or punched. After installation of conduit, the opening shall be flashed and caulked to provide a weather-tight seal. Fire barrier caulk shall be used if the exterior wall is designated as a fire wall.

F. DIRECT BURIED UNDERGROUND CONDUIT

1. Unless otherwise indicated, all underground conduit located outside building areas shall have a minimum slope of 1/2% toward the drainage point, or as shown on the Drawings, and shall be a minimum of three feet (3'-0") below finish grade to the top of the conduit.

2. Trenching, excavation, and backfilling for all underground conduit shall be accomplished as hereinafter specified or shown on the Drawings.

3. Trench widths shall be kept to a minimum and bottoms shall be graded to a uniform slope. The bottom of the trench shall be kept free of water. If required to protect the excavation or personnel, shoring and sheeting of a design and materials suitable to maintain the trench in a safe and workable condition shall be provided. Adequate barricades shall be installed around excavations to protect workmen and the public during the construction. Provide temporary supports for all underground utilities crossing an excavation.

4. Conduit in trenches shall be supported throughout the entire length on solid earth.

5. All metallic conduit directly buried in earth shall be completely coated with two 15- to 18-mil thick coats of an approved bitumastic coal tar protective coating or two coats of 3M Scotchrap pipe primer overwrapped in accordance with the manufacturer's written instructions with 3M No. 51 tape before the conduit trench is backfilled. Rigid metal conduit shall extend 18-inches below grade before converting to Schedule 40 PVC conduit.

6. Backfill for trenches containing direct buried conduit shall be in accordance with Section 310000 – Earthwork. Any settlement shall be corrected by refilling and retamping. No puddling will be permitted.

7. Underground conduits shall be at least 12 inches away from gas, water or other pipe lines.

8. Conduits shall have long swept elbows.

   a. Size 2" and below – 24" minimum radius

   b. Size 2-1/2" and above – 36" minimum radius

9. Factory elbows for conduit sizes 2 inches and larger shall be rigid galvanized steel Schedule 40 with corrosion protection applied as specified herein.

10. Couplings for conduits in a common trench shall be staggered at least 6 inches. All joints shall have watertight seals.

11. All PVC conduit couplings, connectors and fittings shall be properly glued to the conduit, pushing the conduit all the way in to the stop on the coupling, and using the adhesive recommended by the manufacturer of the PVC conduit.

G. UNDERGROUND CONDUIT WARNING TAPE

1. Unless otherwise indicated, the location of all directly buried conduits shall be marked by burying one a warning tape below grade in the backfill. The warning tape shall be placed 18 inches above the top of the conduit(s) and shall be parallel along the full length of the run. Where the top of the conduit(s) is less than three feet (3'-0") below finish grade the warning tape shall be placed 12 inches above the top of the conduit(s).

2. Contractor shall exercise care to ensure that the warning tape is properly located.

H. CONDUIT/DUCT PLUGS

1. Install conduit/duct plug in all spare (empty) conduits/ducts as indicated on the Drawings to prevent vermin from entering electrical equipment through the conduit.

2. Size plugs based on the trade size of the conduit/duct to be sealed.

3. Tie-off pull tape/string to eye on duct plug before inserting into conduit/duct to be sealed.

4. Install plugs in accordance with the manufacturer's directions. Plugs shall be inserted in the conduit or duct such that they fit flush with the end of the raceway. Tighten down the nut to create a water-tight seal but do not over-tighten.

3.2 UNDERGROUND UTILITIES

A. The Contractor shall communicate with Missouri One Call, telephone 1-800-DIG-RITE (1-800-344-7483), 72 hours in advance of any underground work for locating publicly owned underground utilities.

B. Before any excavations are begun, the Contractor shall communicate with the Owner and obtain, if possible, the exact location of any privately underground structures or utilities located in the vicinity of the excavation.

C. Existing underground utilities shown on the Drawings are based on available record documents obtained from the Owner, but their accuracy is generally unconfirmed. Existing underground utilities in the areas of construction are believed to be private and therefore, will not be located by the Missouri One Call program. Obtain field utility locates from a private utility locate company prior to performing any excavation work.

D. The Contractor shall use extreme care and caution during excavation and backfilling to avoid damage to any existing underground structures and utility lines. Prior to and during excavation, the Contractor shall use every means to determine the exact location of all underground structures, electrical conduit, pipe lines, telephone cables, water lines, gas lines, sewer lines, conduit duct banks, etc., in the immediate vicinity of the excavation.

E. The Contractor shall be solely responsible for the protection, repairs, or replacement of any existing underground item which was broken or otherwise damaged by the Contractor, including any consequential damage resulting therefrom, either above or below ground.

F. All conduit, water, gas, and sewer pipes adjacent to or crossing excavations shall be properly supported and protected by the Contractor.

END OF SECTION 260533.13

SECTION 260533.16 – BOXES FOR ELECTRICAL SYSTEMS

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 SCOPE

A. The Contractor shall furnish and install all electrical boxes as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.13 – Conduit for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Outlet and non-dimensioned junction and pull boxes and device boxes
2. Dimensioned junction and pull boxes

PART 2 - PRODUCTS

2.1 GENERAL

A. All electrical boxes, including extension rings, plaster rings, covers and other accessories, shall be UL Listed and Labeled.

B. All outlet, device and non-dimensioned junction and pull boxes shall be sized in accordance with the allowable wiring fill permitted by the National Electrical Code (NEC).

C. Junction boxes and pull boxes shall be sized in accordance with the NEC or as shown on the Drawings.

D. Outlet boxes shall be of the size and type to accommodate the structural conditions, the size and number of raceways, conductors or cables entering, and the wiring device with which the box is intended to be used. Install blank plates on all outlet boxes where apparatus is installed which does not, in itself, provide a cover for the box.

E. Unless otherwise indicated, all junction or pull box covers shall be fastened with cadmium plated or galvanized steel screws or bolts for indoor applications and stainless-steel screws or bolts for outdoor applications. The removable cover shall be fabricated from the same material as the box, and the cover shall be on the largest accessible side of the box unless otherwise indicated. The cover of the box shall be designed for quick removal.

F. Boxes shall be as manufactured by Appleton Electric Company, Eaton Crouse-Hinds, Steel City, Raco, Killark Electric Manufacturing Company, O-Z/Gedney Company, Hoffman Engineering Company, Wiegmann or approved equal.

2.2 BOXES FOR NONHAZARDOUS AREAS

A. Non-dimensioned junction and pull boxes and device boxes located indoors shall be hot-dipped galvanized drawn steel, 4-inch square, 4-11/16-inch square or octagon, 1-1/2 inch minimum depth, NEMA Type 1 with plaster ring, if/as required. Sectional boxes are not acceptable.

B. Non-dimensioned junction boxes located outdoors shall be cast, cadmium or zinc plated malleable iron or "copper-free" aluminum, having threaded hubs and neoprene gasketed covers fastened with four (4) stainless steel screws, NEMA Type 4, Crouse-Hinds Type GRFX, or GS, or approved equal, or Crouse-Hinds, Appleton Electric or Killark 2-1/8 inch deep Type FD, or approved equal.

C. Dimensioned junction and pull boxes located in the Power Plant Control Room or Office shall be painted steel, galvanized steel or code gauge sheet aluminum, NEMA Type 1 having removable neoprene gasketed covers fastened with cadmium plated or galvanized steel screws, and continuously welded seams (ground smooth) with no holes or knockouts.

D. Dimensioned junction and pull boxes located in the Power Plant shall be painted steel, galvanized steel or code gauge sheet aluminum, NEMA Type 12 having removable neoprene gasketed covers fastened with cadmium plated, galvanized or stainless-steel screws, and continuously welded seams (ground smooth) with no holes or knockouts.

1. All enclosures that contain terminal blocks or control components shall be furnished with "fast-operating" junction box clamps allowing the hinged door to be opened without the use of any tools.

2. Inner Back Panels: Provide white painted steel or code gauge sheet aluminum inner back panel, to match box construction, inside all boxes in which terminal blocks or wiring devices are located.

E. Dimensioned junction and pull boxes located outdoors, above grade shall be Type 304 stainless steel, NEMA Type 4X having hinged, neoprene gasketed covers fastened with 304 stainless steel screws, and continuously welded seams (ground smooth) with no holes or knockouts.

1. Inner Back Panels: Provide Type 304 stainless steel inner back panel, to match box construction, inside all boxes in which terminal blocks or control components are located.

F. Pull and junction boxes shall be sized in accordance with NEC Article 314-16 or 314-28 as a minimum. Larger boxes may be provided.

G. Provide hinged cover enclosures for any box larger than 12 inches in any dimension.

H. Provide grounded metallic barriers in dimensioned junction and pull boxes as required to isolate power circuits from other types of circuits. Barriers shall be designed so as not to separate the phases of a power circuit. Barriers shall be constructed of the same material as the box in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Boxes, General

1. Non-metallic boxes shall not be used on this project.
2. Locate and install boxes to allow access. Coordinate with other trades to ensure boxes are not made inaccessible by equipment, duct work or piping installation.
3. Locate and install to maintain headroom and to present a neat appearance.
4. Special care shall be taken to set all boxes square and true with the building finish. As far as possible, all boxes shall be secured to the building structure or steel, using adjustable supports where necessary.
5. Outlet boxes in unfinished areas shall be surface (exposed) mounted to columns or walls, unless otherwise indicated.
6. The location of all outlets shall be obtained from the Drawings. The Construction Representative or the Designer shall be allowed to relocate any item within a 10-foot radius from the scaled location on the plans without additional cost to the Owner, provided this is done prior to or during rough-in and before finish installation.
7. Final correct readjustment shall be made to outlet boxes, if necessary, to give proper centering. In centering and location of outlet boxes, allowance shall be made for overhead pipes, ducts, and other mechanical equipment and for variation in the arrangement and thickness of walls, fireproofing, etc. Any inaccuracy resulting from failure to take the above into consideration shall be corrected by the Contractor without additional expense to the Owner.
8. Boxes located in damp or wet locations shall have stainless steel or other Designer approved corrosion resistant spacers installed to provide a minimum of 1/4-inch air space between the back of the box and the mounting surface.
9. All boxes shall be rigidly mounted.
10. Securely fasten boxes to building structure, independent of the conduit, except for splice boxes that are connected to two metal conduits, both supported within 12 inches of the box.
11. All conduits entering sheet metal junction or pull boxes shall be through holes properly cut with a punch and die. Cast boxes shall be provided with threaded conduit bosses or hubs of proper size and externally located cast feet for mounting.
12. All open conduit knockouts, holes or hubs in electrical enclosures that are not used shall be properly plugged with suitable blanking devices of the same material as the box that maintain the NEMA rating of the box. Utilize stainless steel blanking devices for stainless steel boxes. Utilize NEMA 12 rated hole seals devices to seal all open holes in the top of all panelboards, switchboards, switchgear, motor control centers, transformers, and in NEMA 12 rated dimensioned junction boxes and pull

boxes. Provide NEMA 4X rated hole seals for NEMA 4X rated junction and pull boxes and electrical enclosures.

13. Junction and pull boxes shall be furnished and installed where indicated on the Drawings, required by code, and wherever else such a box may be deemed necessary to facilitate the pulling or splicing of wires or cables. In general, junction or pull boxes shall be installed to limit conduit runs to 125 feet and conduit bends to a maximum total of 360 degrees. The Contractor shall furnish and install properly sized pull boxes wherever necessary in order that a run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter (90 degree) bends (360 degrees total). Additional pull boxes may be needed to facilitate wire pulling. All boxes shall be installed in locations that will be accessible after completion of the construction.

14. Dimensioned pull and junction boxes shall be sized in accordance with NEC Article 314-28 unless a larger size box is indicated on the Drawings.

15. If strain relief members need to be installed inside junction and pull boxes or electrical equipment enclosures, for example to prevent large conductors entering the back of a box from pressing against the inside of the removable cover, utilize fiberglass U-channel support members. Do not install any wood, or other combustible type materials, inside any electrical enclosure.

16. Location of junction and pull boxes shall be approved before installation. Where necessary, conduits may be rerouted with the approval of the Construction Representative.

17. Rigid metal conduits terminating in all NEMA Type 3, 3R, 4, 4X, 12 or 13 boxes and enclosures, without integral cast threaded hubs shall be terminated in insulated throat, grounding type, liquid tight, rigid conduit hubs. Conduit hubs shall be provided in accordance with Section 260533.13 – Conduit for Electrical Systems.

18. Provide a grounding type conduit bushing with solderless lug and copper bonding jumper sized in accordance with NEC Article 250 for all conduits terminating in NEMA Type 1 boxes and enclosures in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.

19. All junction boxes and pull boxes with a hinged cover shall be installed such that the cover can be opened at least 90 degrees.

20. Junction and pull boxes with a hinged cover that are located on a wall shall be mounted such that the cover opens to the right or to the left but not up or down.

3.2 CIRCUIT IDENTIFICATION

A. Junction, pull, outlet, and device boxes shall be identified in accordance with the requirements of Section 260553 – Identification for Electrical Systems.

B. Cover plates for all non-dimensioned junction and pull boxes shall be marked on the inside surface of the cover plate in finished areas or on the outside surface of the cover in unfinished areas with the voltage, panel and circuit number(s) of the branch circuit(s) contained inside the box in accordance with Section 260553 – Identification for Electrical Systems.

C. Nameplates shall be provided on the external surface of the cover for all dimensioned junction and pull boxes which shall identify the source voltage of the circuits inside the

box as well as the location of the power source for these circuits and the designation of the box, if any, as indicated on the Drawings.

D. All conductors in every junction or pull box shall be identified in accordance with Section 260553 – Identification for Electrical Systems.

END OF SECTION 260533.16

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

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 SCOPE

A. The Contractor shall furnish and install electrical identification for electrical equipment, conductors, cables, and boxes as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260513 – Medium-Voltage Cables

C. Section 260519 – Low-Voltage Electrical Power Conductors & Cables

D. Section 260533.13 – Conduit for Electrical Systems

E. Section 260533.16 – Boxes for Electrical Systems

F. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

G. Section 261316 – Medium-Voltage Fusible Load-Interrupter Switchgear

H. Section 261350 – Neutral Grounding Resistor

I. Section 262416 - Panelboards

J. Section 262419 – Motor Control Centers

K. Section 262816.16 – Enclosed Switches

L. Section 263213.16 – Diesel-Engine-Driven Generator Set Controls

M. Section 263290 – Medium-Voltage Generator Connection Cabinet

N. Section 263623 – Medium-Voltage Automatic Transfer Switches

1.4 SUBMITTALS

A. Submit electrical identification data as follows:

1. Nameplate type product data
2. Nameplate engraving schedule
3. Conduit marker product data
4. Wire and cable identification label product data

5. Medium-voltage power circuit identification tags
6. Arc flash hazard warning labels

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be three-layer laminated plastic with engraved black characters on a white background or engraved white characters on a red background as indicated on the Drawings.

B. Nameplates that will be located outdoors must be constructed from material that is weatherproof and resistant to ultraviolet light.

C. Nameplate engraving shall be as follows:

1. Lettering font shall be Gothic.
2. Nameplate character sizes shall be:
    a. 3/4-inch high – Switchgear, neutral grounding resistor, motor control center, generator connection cabinet, automatic transfer switch
    b. 1/2-inch high – Panelboards
    c. 3/8-inch high – Control panels, enclosed switches, motor controllers, terminal boxes, dimensioned junction boxes and dimensioned pull boxes.
    d. 1/8-ingh high – Local control stations
3. Lettering shall be centered on nameplate.
4. Nameplates shall have a maximum of forty (40) characters per line with a maximum of four (4) lines.
5. Wording on each nameplate shall contain the following information as appropriate:
    a. Equipment designation as indicated on the Drawings, such as: PANEL DP1
    b. Voltage and phases, such as: 480V-3PH-3W
    c. Designation of source equipment, such as: FED FROM SWBD B1
    d. Location of source equipment, such as: ELECTRICAL RM
6. Nameplates on control panels and terminal boxes shall indicate the panel name such as “GVCP”, the source panelboard and circuit it is served from such as “PP1-33 and the service voltage such as: “120VAC”.
7. Engraving designations shall be approved by the Designer through the shop drawing submittal process.

D. Special nameplates that are both waterproof and ultraviolet resistant shall be provided in accordance with Ameren Document C0 that is included as an attachment to Section 263623 – Medium-Voltage Automatic Transfer Switches, shall be provided as follows:

1. Next to the Ameren revenue meter at the southeast exterior corner of the Power Plant with the following wording (Minimum size of nameplate shall be 5”x7”.):
    a. BACKUP GENERATION PRESENT
Lockable Visible Open Disconnect
Available for Isolation

2. On the front door of the service entrance 4.16 kV fusible load-interrupter switchgear below the switch blade viewing window with the following wording:

a. LOCKABLE VISIBLE OPEN DISCONNECT
FOR ISOLATION FROM GENERATOR

E. Additional special nameplates shall be provided as indicated on the Drawings.

2.2 CONDUIT MARKERS

A. Conduit markers shall be vinyl "peel and stick" type with black characters on an orange background:

1. Conduits 1-1/4" and smaller characters..... 1/2”

2. Conduits 1-1/2” and larger characters..... 1”

B. Markers shall identify voltage and functional use of the conduit, such as “4160V 3-PHASE”, “480V 3-PHASE”, “120/208 VOLT”, “120 VOLT”, “EMERGENCY FEEDER”, “CONTROL”, “INSTRUMENTATION”, etc.

2.3 WIRE LABELS AND CABLE MARKERS

A. Wire labels for No. 4/0 AWG and smaller wires shall be vinyl film, self-laminating, adhesive wraparound type; W. H. Brady Co. B-292, Thomas & Betts WSL Series or approved equal.

B. Cable markers for cables and wire labels for all conductors 250 KCM and larger shall be polyester film, non-adhesive, plate type designed for cable tie banding parallel to the cable/conductor.

C. Wire and cable identification numbers shall be printer generated or typewritten on the labels and markers.

D. Character size for cable identification numbers shall be a minimum of 1/8-inch high.

E. Markers labels, number generation method, and attachment methods shall be subject to the approval of the Engineer.

2.4 MEDIUM VOLTAGE POWER CIRCUIT IDENTIFICATION TAGS

A. Provide engraved stainless-steel tags with 1/8-inch-high characters.

B. Cable identification shall include the following information:

1. Installation date; e.g., “MM/YYYY”

2. Conductor size and material; e.g., “350KCM CU”

3. Cable type; e.g., “MV-105, 133% EPR”

4. Source and destination; e.g., “SE SWGR to MTRG SWGR”

2.5 ARC FLASH HAZARD WARNING LABELS

A. Warning labels for electrical equipment shall be color printed, waterproof, Designer approved, and Contractor furnished and installed.

B. For incident energy values less than or equal to 40 cal/cm2, label shall indicate "WARNING" using black lettering on an orange background. The remainder of the label shall have black characters on a white background.

C. For incident energy values greater than 40 cal/cm2, label shall indicate "DANGER" using white lettering on a red background. The remainder of the label shall have black characters on a white background.

D. Labels installed outdoors shall be weatherproof and resistant to ultraviolet light.

E. At a minimum, each label shall include the following:

1. Equipment location
2. Source protective device name providing the protection (fed from)

   NOTE: The protective device name shall use the designations of equipment on the Project Drawings rather than names assigned within the power system study software model.
3. Nominal system voltage
4. Arc flash boundary
5. Specific arc incident energy available
6. Maximum available fault current (This is the value calculated using the ANSI fault current evaluation method and listed in the ANSI short circuit evaluation table that is used for establishing the minimum SCCR of the equipment.)
7. Label date

NOTE: Print appropriate information on label based on the arc flash risk assessment report provided in accordance with Specification Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

F. Size of warning labels shall be:

1. Equipment main bus rating less than 400A: 3.5" x 5"
2. Equipment main bus rating 400A or more: 5" x 7"

2.6 COLOR CODE TAPE

A. Each circuit conductor and power cable shall be color coded with colored insulation/cable jacket. Where colored insulation/cable jacket is not available for a particular conductor size or type, color code the conductor/power cable with 3M No. 35 tape, 3/4" width.

2.7 PANELBOARD CIRCUIT DIRECTORIES

A. Each panelboard shall have a framed circuit directory card with a clear plastic covering mounted on the inside of the door.

B. The directory card shall provide a space at least 1/4-inch high by 3 inches long, or the equivalent, for each circuit.

C. The directory card shall be typed to identify the load fed by each circuit for compliance with NEC 408.4.

PART 3 - EXECUTION

3.1 GENERAL

A. Degrease and clean surfaces to receive nameplates, markers, labels and color code tape.

B. All nameplates, labels, markers and panelboard circuit directories must be installed prior to turning operation of the equipment over to the Owner.

3.2 NAMEPLATES

A. Nameplates shall be provided for each switchgear, switchgear fusible load-interrupter switch, neutral grounding resistor, panelboard, motor control center, including each individual motor control center bucket, generator connection cabinet, automatic transfer switch, enclosed switch, control panel, terminal box, dimensioned pull box, dimensioned junction box, and local control station.

B. Nameplates shall be secured with an approved adhesive such as Goodyear “Pliobond” glue. Self-tapping screws or sheet metal screws shall not be used.

C. The nameplate provided for the Ameren revenue meter as specified in Paragraph 2.1 D.1 in this section shall be affixed to the masonry wall adjacent to the east side of the meter enclosure with stainless steel expansion bolts.

3.3 CONDUIT MARKERS

A. Attach a conduit identification marker to each conduit at all termination points and at 20' intervals along the entire length of the conduit.

B. Secure markers parallel to conduit in a location that is readily visible from the floor or grade level.

3.4 WIRE LABELS AND CABLE MARKERS

A. Power feeders, branch circuits, control and signal wires and cables shall be identified.

1. Attach a wire identification label to each conductor of a circuit cable group at each termination point.

2. Attach a cable identification marker to each circuit cable group at all termination entry points.

B. Wire labels and cable markers shall identify each conductor and cable with the circuit number. Identify with branch circuit or feeder number for power circuits and with control wire or cable number as indicated on schematic and interconnection diagrams and equipment shop drawings for control wiring.

C. Cable markers for cables and wire labels for all conductors 250 KCM and larger shall be secured with heavy duty plastic cable ties. Cut excess tie material off flush with tie clasp. Do not leave sharp edges.

3.5 MEDIUM-VOLTAGE POWER CIRCUIT IDENTIFICATION

A. Securely fasten identifying stainless-steel tags to the medium-voltage cables in all new and existing medium-voltage switchgear, neutral grounding resistor, medium-voltage

generator connection cabinet, medium-voltage automatic transfer switch, cable vaults, underground handholes and manholes, junction boxes and pull boxes using one-piece self-locking nylon cable ties. Cut off excess cable tie. Do not leave sharp edges.

B. Install identification tags in locations where they are easily readable.

3.6 ARC FLASH WARNING LABELS

A. Provide arc flash hazard warning labels in accordance with NEC Article 110-16 and Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment for the following equipment:

1. All new and existing switchgear, switchboards, panelboards, motor control centers, low-voltage distribution transformers, motor controllers (motor starters), variable-frequency motor controllers (VFDs), enclosed switches (disconnect safety switches) 30A and larger, enclosed circuit breakers, neutral grounding resistor, medium-voltage generator connection cabinet and medium-voltage automatic transfer switch

B. Labels shall be applied to the outside of the front cover at the center of the cover such that the label is clearly visible with the door closed.

C. Switchgear, switchboards, panelboards, motor control centers and the medium-voltage automatic transfer switch, which have multiple sections, shall have one 5" x 7" label applied to each section.

D. Clean the surface to which each label is to be applied with denatured alcohol or a similar, fast evaporating cleaning agent that will not damage the paint finish.

3.7 CABLE/CONDUCTOR COLOR CODING

A. Each power circuit conductor and power cable shall be color coded with colored insulation. Identify conductors/cables not available color coded from the manufacturer by field application of electrical color code tape. Per NEC 200.6(A), neutral conductors size 6 AWG and smaller must have white colored insulation from the factory. It is not permissible to field mark neutral conductors that are size 6 AWG and smaller with white tape.

1. Color coding for 600-volt conductors shall be:

120/240V 1 Phase	120/208V 3 Phase	480V 3 Phase
Phase A Black	Phase A Black	Phase A Brown
Phase B Red	Phase B Red	Phase B Orange
Neutral White	Phase C Blue	Phase C Yellow
Equipment Ground Green	Neutral White	Equipment Ground Green
	Equipment Ground Green	

2. Color coding for 4,160-volt cables shall be:

4,160V 3 Phase
Phase A Black
Phase B Red
Phase C Blue
Equipment Ground Green
NOTE: Confirm color coding of existing 4.16kV feeders at the facility and advise the Designer if different than the above.

B. Wiring to contacts powered from a source external to a control panel shall be yellow.

C. Conductors for direct current (DC) circuits shall be color coded red for positive (+) conductor and black for negative (-) conductor.

D. Apply tape in a uniform manner circling wire or cable. Half-lap tape for length of cable as required by Local Authorities or NEC but not less than five (5) full wraps.

3.8 JUNCTION, PULL, OUTLET AND DEVICE BOX IDENTIFICATION

A. Cover plates for all non-dimensioned junction and pull boxes shall be marked on the inside surface of the cover plate in finished areas or on the outside surface of the cover in unfinished areas with the voltage, panel and circuit number(s) of the branch circuit(s) contained inside the box. Marking shall be with printer generated "peel and stick" labels.

B. Nameplates shall be provided on the external surface of the cover of all dimensioned junction and pull boxes which shall identify the source voltage of the circuits inside the box as well as the location of the AC power source(s) for these circuits.

C. All conductors in every junction or pull box shall be identified as specified herein.

3.9 PANELBOARD CIRCUIT DIRECTORIES

A. Provide new "updated" directory cards for existing panelboards where indicated on the drawings and/or where circuits have been rearranged, added or deleted.

B. Provide a circuit directory card for each new panelboard furnished on this project.

C. Each directory card shall be printer generated to identify the load served by each circuit.

D. Remove existing circuit directory cards and/or circuit labeling on the panelboard cover or dead-front panel.

E. Trace out unidentified circuits in existing panelboards and indicate load served on new circuit directory for compliance with NEC 408.4.

END OF SECTION 260553

SECTION 260573 – PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH RISK ASSESSMENT

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 SECTION INCLUDES

A. This Section includes computer-based fault-current, overcurrent protective device coordination and arc flash risk assessment studies, and the setting of these devices and application of proper arc flash hazard warning labeling to equipment.

1. *Coordination Study Report shall include*: Short circuit analysis, time current characteristics for all protective devices, graphical demonstration of selectivity, relay and overcurrent protection device instruction books, and pertinent manufacturer data, and Missouri registered Professional Engineer seal and signature.
2. Arc flash risk assessment report, with Missouri registered Professional Engineer seal and signature.
3. Series ratings of protective devices are not acceptable unless specifically authorized by the Designer for existing equipment. These situations will be addressed on a case-by-case basis.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260553 – Identification for Electrical Systems

C. Section 261316 – Medium-Voltage Fusible Load-Interrupter Switchgear

D. Section 261350 – Neutral Grounding Resistor

E. Section 262416 – Panelboards

F. Section 262419 – Motor Control Centers

G. Section 262813 – Fuses

H. Section 262816.16 – Enclosed Switches

I. Section 263290 – Medium-Voltage Generator Connection Cabinet

J. Section 263623 – Medium-Voltage Automatic Transfer Switches

1.4 SUBMITTALS

A. Study documentation

1. *Product Certificates*: For coordination study and fault-current study computer software programs, certifying compliance with IEEE 399

2. *Qualification Data*: For fault-current study and arc flash risk assessment specialist who shall be a professional engineer registered in the State of the Missouri

3. Demonstrate experience with Arc Flash Risk Assessment by submitting names of at least three actual Arc Flash Risk Assessments performed in the past year.

4. Demonstrate capabilities in providing equipment, services, and training to reduce Arc Flash exposure.

5. Demonstrate experience in providing equipment labels in compliance with NFPA 70 (2011 edition), Article 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

6. Single-line diagram

   a. Include as installed cable/conductor lengths, size and number of conductors for each circuit segment.

7. Fault-current study report

8. Coordination study report including completed computer program input data sheets

9. Equipment evaluation report

10. Overcurrent protective device settings report

11. Arc flash risk assessment report

B. Submit an electronic copy of the fault-current, overcurrent protective device coordination, and arc flash risk assessment studies for review and comment prior to or along with all submittals related to new overcurrent protective devices to be furnished on this project; medium-voltage power fuses, medium-voltage circuit breakers and the associated protective relays, low-voltage (< 600V) circuit breakers, fuses, etc.

C. Final report

1. Provide two (2) bound copies of the approved fault-current, overcurrent protective device coordination, and arc flash risk assessment studies bound in 8-1/2-inch by 11-inch volumes with drawings and diagrams folded to fit the 8-1/2-inch by 11-inch format, sealed and signed by licensed Missouri Professional Engineer. Report cover shall be extra heavy weight paper (80 lb. or heavier). Report data shall be printed on 8-1/2-inch by 11-inch paper. Diagrams, drawings, and coordination curves shall be printed on 11-inch by 17-inch paper unless larger size drawings, 36-inch x 42-inch maximum size, are required for legibility. Securely retain larger size drawings by folding and placing them in pockets bound into report.

2. Provide one complete copy of all report documentation electronically to include all data files, drawings and diagrams. File types for the report documentation should be .doc, .pdf, .dwg, or .xls. In addition, provide complete study files, in the native SKM software format, electronically to include all models, data, single lines, etc. Transmission of electronic files to the State of Missouri Office of Administration, Division of Facilities Management, Design and Construction shall be by uploading to the State's project management system, Trimble (fka eBuilder), web site.

D. General report requirements:

1. Include all facility power distribution system equipment located at the Moberly Correctional Center Power Plant, both inside and outside, and all 4.16kV distribution equipment throughout the Moberly Correctional Center Facility, including all step-down transformers and the first switchboard, panelboard, enclosed fusible switch or enclosed circuit breaker on the secondary side of the step-down transformer, including but not limited to the equipment shown on Project Drawings E-601, E-602 and E-603.

2. Provide identification and description of industry testing standards on which study is based, for each section of study.

3. Provide calculations, impedance diagrams, conclusions, and recommendations as part of study general content.

4. Provide short circuit tabulations which include system impedances, X/R ratio, asymmetry factor, kVA, and symmetrical and asymmetrical fault currents.

5. Provide each study with following:

   a. Coordination plots which graphically indicate coordination proposed for several systems. Provide plots centered on full scale log-log-forms.

   b. Coordination plots with complete titles, representative one-line diagrams and legends, associated power company's system characteristics, significant motor starting characteristics, complete parameters for power, fuses, if applicable, and associated system load protective devices.

   c. Coordination plots which define types of protective devices selected, with proposed coil taps, time dial settings, and pick-up settings required.

   d. Long time region of coordination plots shall indicate complete tap scale for each relay and full load current transformer parameters and designate pick-ups required for low voltage circuit breakers.

   e. Short time region shall indicate low voltage circuit breaker, short time and instantaneous trip devices, fuse manufacturing tolerance bands, when applicable, and significant symmetrical and asymmetrical fault currents.

6. Coordinate each item of equipment as follows:

   a. Separate low voltage power circuit breakers from each other by 16 percent current margin for coordination and protection in event of secondary line-to-line faults.

   b. Terminate protective device characteristics or operating band to reflect actual symmetrical and asymmetrical fault currents sensed by device.

   c. Prepare study with network analyzer, computer, or by written calculations. Include complete fault calculations as specified for each proposed and ultimate source combination.

   d. Source combinations include proposed and future large motors or generators.

E. Drawings and specifications indicate general requirements for motors, motor starter equipment, and low voltage equipment. Determine additional specific characteristics of equipment furnished in accordance with results of short circuit and protective device coordination study.

1. Short circuit protective device coordination and arc flash study shall be coordinated with the Contractor provided shop drawings for new equipment to be furnished on this project and existing conditions.
2. Submit equipment design discrepancies and proposed corrective modifications, if required, with short circuit and protective device coordination study. Identify variations clearly on shop drawings.
3. Provide equipment, overcurrent devices, field settings, adjustments and minor modifications for conformance with approved short circuit and protective device coordination study.
4. Identify existing equipment that is overstressed with recommended solution, including series rating of the equipment if that is possible.
5. Identify areas of electrical miscoordination with recommended solutions.
6. Identify National Electrical Code violations observed during collection of existing condition information on-site and/or during the preparation of the short circuit, protective device coordination and arc flash risk assessment studies with recommended solution.

1.5 APPLICABLE STANDARDS

A. The latest edition of the following industry standards shall apply to the work specified herein:

1. ANSI/IEEE C37.46 – Power Fuses and Fuse Disconnecting
2. ANSI/IEEE C37.50 – Low-Voltage AC Power Circuit Breakers Used in Enclosures – Test Procedures
3. ANSI Z535.4 – Product Safety Signs and Labels, Includes Errata
4. ICEA P-32-382 – Short Circuit Characteristics of Insulated Cable
5. ICEA P-45-482 – Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables
6. IEEE 141 – IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)
7. IEEE 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
8. IEEE 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book)
9. IEEE 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)
10. IEEE 1015 – IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (IEEE Emerald Book).
11. IEEE 1584 – IEEE Guide for Performing Arc Flash Calculations
12. NFPA 70 – National Electrical Code
13. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
14. NFPA 70E – Standard for Electrical Safety in the Workplace

15. International Electrical Testing Association, Inc. (NETA) – Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

1.6 QUALITY ASSURANCE

A. Studies shall use licensed computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. *Coordination-Study Specialist Qualifications*: An organization experienced in the application of computer software used for electrical short circuit analysis and coordination studies having performed successful studies of similar magnitude on electrical distribution systems using similar devices. The coordination study shall be performed by a Missouri State registered professional electrical engineer, in accordance with ANSI/IEEE Standard 242, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems."

C. *Testing Agency's Field Supervisor*: Person currently certified by the International Electrical Testing Association to supervise testing specified herein.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

1.7 ACCEPTABLE STUDY PROVIDERS

A. *Protective Device Coordination Study and Arc Flash Risk Assessment Report Provider*: Subject to compliance with requirements, study shall be commissioned by Division 26 and provided by State of Missouri registered professional engineer from one of the following study providers:

1. BHMG Engineers, Inc., Corey Jasper, P.E. (314-686-1216)
2. Eaton EESS, Kyle Crangle (636-734-2316)
3. ABB Services, Roger Andrews (913-286-8028)
4. Other qualified State of Missouri registered professional engineer, subject to approval of the Designer.

1.8 COMPUTER SOFTWARE PROGRAM

A. *Computer Software Program*: Subject to compliance with requirements, the protective device coordination study and arc flash risk assessment shall be provided using the latest version of SKM Power Tools Electrical Engineering Software (PTW 32) by SKM Systems Analysis, Inc., ESA, Inc., or CYME International, Inc.

1.9 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Computer software program must comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory", "very desirable", and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall provide plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Additional Program Features:

a. Arcing faults

b. Simultaneous faults

c. Explicit negative sequence

d. Mutual coupling in zero sequence

e. Arc flash risk assessment

1.10 EXAMINATION

A. There is not an existing short circuit, protective device coordination or arc flash risk assessment study available for this facility so an existing power system model is not available to use as a baseline for the study specified herein.

B. Examine submittals for new protective devices furnished on this project for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated shall be as indicated on the one-line diagrams on the Drawings.

C. Proceed with coordination study only after relevant equipment submittals have been assembled. Protective devices not submitted for approval with coordination study may not be used in study. Protective devices submitted prior to this coordination study will be reviewed, but final approval will be contingent upon the study results.

D. Study specialist must visit the project site to confirm the lengths of existing feeders to a reasonable level of accuracy and to field verify all information shown on the project drawings, including but not limited to:

1. Ratings of existing equipment

2. Transformer ratings and impedances

3. Overcurrent protective device sizes/ratings

4. Conductor types and sizes

5. Conduit types (magnetic or non-magnetic)

6. Feeder lengths

E. Update project one-line diagrams with information obtained from field verifications.

1.11 FAULT-CURRENT STUDY

A. Fault study shall incorporate the following available utility fault information that was provided by Ameren Missouri on 6/17/2025:

1. Preferred Source (Ameren Missouri SINNOCK-72 via SWITCH 3021):

a. Fault Location: Substation transformer secondary bushings

b. Fault Voltage: 4.16 kV

c. 3-Phase Fault Current: 3.47 kA

d. L-G Fault Current: 3.81 kA

e. System X/R Ratio: 7.59

f. System X_0/R_0 Ratio: 13.08

2. Reserve Source (Ameren Missouri SINNOCK-72 via SWITCH 3031):

a. Fault Location: Substation transformer secondary bushings

b. Fault Voltage: 4.16 kV

c. 3-Phase Fault Current: 3.38 kA

d. L-G Fault Current: 3.74 kA

e. System X/R Ratio: 6.64

f. System X_0/R_0 Ratio: 13.08

3. Transformer Data:

a. Mineral oil filled substation type

b. 3-phase

c. 34.4 kV Delta – 4.36Y/2.52 kV

d. 2.5/2.8/3.125/3.5 MVA

e. 7.18 %Z

f. X/R Ratio: 13.08

B. Confirm the accuracy of this information with:

Ameren Missouri Construction Services
866-992-6619
servicerequest@ameren.com

C. Study electrical distribution system for both the "Preferred" and "Reserve" source switching scenarios as well as for the alternate source (existing 1450kW/1812.5 kVA diesel-engine-driven generator) using an approved computer software program to calculate values in order to determine the maximum fault conditions.

D. Calculate momentary and interrupting duties based on the maximum available fault current.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50

2. Low-Voltage Fuses: IEEE C37.46

3. Circuit Breakers: IEEE C37.13

F. Fault study must be completed and submitted prior to proceeding with procurement/manufacturing of the following new equipment:

1. Medium-voltage fusible load-interrupter switchgear under Section 261316 – Medium-Voltage Fusible Load-Interrupter Switchgear

2. Neutral grounding resistor under Section 261350 – Neutral Grounding Resistor

3. Circuit breaker panelboards under Section 262416 – Panelboards

4. Motor control center under Section 262419 – Motor Control Centers

5. Enclosed switches under Section 262816.16 – Enclosed Switches

6. Medium-voltage generator connection cabinet under Section 263290 – Medium-Voltage Generator Connection Cabinet.

7. Medium-voltage automatic transfer switch under Section 263623 – Medium-Voltage Automatic Transfer Switches

G. *Short Circuit Study Report*: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including monetary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

H. *Equipment Evaluation Report*: Prepare a report on the adequacy of protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties. Identify existing equipment that is overstressed with recommended solution, including series rating of the equipment if that is possible. If series ratings for protection of existing electrical equipment are approved by the Designer, provide caution labels for all series rated equipment for compliance with NEC 240.86 and 110.22(B) or (C).

1. Equipment evaluation report shall include all facility power distribution system equipment located at the Moberly Correctional Center Power Plant, both inside and outside, and all 4.16kV distribution equipment throughout the Moberly Correctional Center Facility, including all step-down transformers and the first switchboard, panelboard, enclosed fusible switch or enclosed circuit breaker on the secondary side of the step-down transformer, including but not limited to the equipment shown on Project Drawings E-601, E-602 and E-603.

1.12 COORDINATION STUDY

A. The final approved settings shall incorporate the results of the Arc Flash Risk Assessment to minimize the hazard associated with the related systems.

B. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Electrical distribution system diagram showing the following:

a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment

b. Medium-voltage fuse ratings and types

c. Medium-voltage circuit breaker ratings and types and the associated protective relay protective functions

d. Low-voltage (< 600V) circuit-breaker and fuse-current ratings and types

e. Transformer kilovolt amperes, primary and secondary voltages, connection types, impedance, and X/R ratios

f. *Cables*: Indicate conduit material, sizes of conductors, conductor insulation, and length

g. Motor horsepower and code letter designation according to NEMA MG 1

3. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram.

a. Special load considerations, including starting inrush currents and frequent starting and stopping

b. Magnetic inrush current overload capabilities of transformers

c. Motor inrush current, locked rotor current, service factor, starting time, type of start, and thermal damage curve

d. Time-current characteristic curves of devices indicated to be coordinated

e. Protective functions to be incorporated on protective relays for medium-voltage circuit breakers

f. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for low voltage circuit breakers

g. Switchgear, neutral grounding resistor, switchboards, panelboards, motor control center, medium-voltage generator connection cabinet, medium-voltage automatic transfer switch, motor controllers (motor starters), variable-frequency motor controllers (VFDs), secondary unit substation transformer, low-voltage distribution transformers, enclosed switches 30A and larger and interrupting ratings in amperes rms symmetrical

C. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

D. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

E. Comply with IEEE 141 and IEEE 242 time intervals.

F. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Self-cooled, full-load current for the transformer.

b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

G. *Neutral Grounding Resistor*: Confirm ampere/resistance rating of the neutral grounding resister specified in Section 261350 – Neutral Grounding Resistor and as shown on the Project 4.16kV One-Line Diagram and recommend changes if/as required.

H. *Conductor Protection*: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify

adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

I. *Medium-Voltage Circuit Breaker Protective Relays*: Indicated the recommended protective functions that are to be utilized in the multifunction solid state protective relays for the utility and generator circuit breakers in the medium-voltage automatic transfer switch specified in Section 263623 – Medium-Voltage Automatic Transfer Switches and provide recommended setting for these relays.

J. *Coordination-Study Report*: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
    a. Device tag
    b. Medium-voltage protective relay settings for each protective function utilized
    c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings
    d. Fuse-current rating and type
    e. Ground-fault relay pickup and time-delay settings
2. *Coordination Curves*: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including existing upstream devices. Show the following specific information:
    a. Device tag
    b. Voltage and current ratio for curves
    c. Three-phase and single-phase damage points for each transformer
    d. No damage, melting, and clearing curves for fuses
    e. Cable damage curves
    f. Transformer inrush points
    g. Maximum fault-current cutoff point
3. Study shall include a narrative identifying any potential coordination short falls and recommendations for change.
4. Completed data sheets for setting of all overcurrent protective devices

1.13 OVERCURRENT PROTECTIVE DEVICE SETTINGS

A. *Manufacturer's Field Service*: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.

B. *Testing*: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
    a. Verify that overcurrent protective devices meet parameters used in studies.

b. Adjust devices to values listed in study results, if overcurrent protective devices are adjustable.

c. “Seal” each relay/adjustable circuit breaker setting access cover with an approved sealing device, Square D “TUSEAL” or approved equal, to prevent unauthorized changes to settings.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures", and Tables 10.7 and 10.8 in NETA “Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems”.

1.14 ARC FLASH RISK ASSESSMENT

A. Gather and tabulate the information provided by the Short Circuit Analysis and the Coordination Study, for the preparation of the Arc Flash Risk Assessment.

B. The intent of the Arc Flash Risk Assessment is to achieve the lowest possible hazard ratings for the associated equipment while still maintaining the code required level of electrical coordination for the system. The results of the risk assessment shall be incorporated into the recommended protective device settings to minimize the arc flash hazard.

C. Scope of Work:

1. The Arc Flash Risk Assessment shall be performed with the aid of computer software intended for this purpose in order to calculate Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

2. The Arc Flash Risk Assessment shall be performed in conjunction with a short-circuit analysis and time-current coordination analysis.

3. Results of the Risk Assessment shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

4. The Risk Assessment shall be performed under worst-case arc flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

5. The Arc Flash Risk Assessment shall be performed by a professional engineer who is currently registered in the State of Missouri.

6. The Arc Flash Risk Assessment shall be performed in compliance with the latest edition of IEEE Standard 1584, the IEEE Guide for Performing Arc Flash Calculations including any and all addendums and errata.

7. The Arc Flash Risk Assessment shall include recommendations for reducing AFIE levels and enhancing worker safety.

8. Prior to final approval, incorporate actual installed cable/conductor lengths into the Arc Flash Risk Assessment.

D. Comply with NFPA 70, NFPA 70E, and NFPA 70B standards for the Arc Flash Risk Assessment Report.

E. Field Labeling and Signage:

1. Provide complete arc flash hazard warning signage per NFPA 70 Article 110-16 on the following equipment:

a. All facility power distribution system equipment located at the Moberly Correctional Center Power Plant, both inside and outside, including all switchgear, neutral grounding resistor, switchboards, panelboards, motor control center, medium-voltage generator connection cabinet, medium-voltage automatic transfer switch, motor controllers (motor starters), variable-frequency motor controllers (VFDs), secondary unit substation transformer, low-voltage distribution transformers and enclosed switches 30A and larger including but not limited to the equipment shown on Project Drawings E-601 and E-603.

b. All 4.16kV distribution equipment throughout the Moberly Correctional Center Facility, including all step-down transformers and the first switchboard, panelboard, enclosed fusible switch or enclosed circuit breaker on the secondary side of the step-down transformer, including but not limited to the equipment shown on Project Drawings E-601 and E-602.

c. All other equipment as required by National Electrical Code (NEC) and/or NFPA 70E requirements.

2. Arc flash hazard warning labels shall be provided in accordance with Section 260553 – Identification for Electrical Systems.

1.15 COORDINATION OF WORK

A. Adjustment of protective device equipment to meet the approved protective device coordination submittal shall be the responsibility of Division 26 at no additional cost to the Owner.

1.16 ARC FLASH TRAINING

A. The arc flash study provider shall train the Owner's personnel on the potential arc flash hazards associated with working on energized electrical equipment. The audience will include employees who work on or near energized electrical equipment, who must be made aware of the associated electrical hazards. The training shall be conducted at the Owner's facility and shall be a minimum of 1 hour and a maximum of 2 hours in duration.

B. The intent of this training is not to "certify" or "qualify" the Owner's maintenance personnel to work on energized electrical equipment or provide an adequate level of training for them to meet the NFPA 70E definition of a "qualified person" but rather to give them a broad understanding of the purpose of arc flash hazard warning labeling and an awareness of the dangers of working on or near energized electrical equipment.

C. A key purpose of the training is to help the attendees become aware of potential shock and arc flash hazards associated with energized electrical equipment and ways to mitigate the risk of injury associated with these hazards.

D. It is not the intent of this training to provide electrical equipment preventative maintenance training.

E. The arc flash training session shall be video recorded by the Contractor in accordance with Section 017900 – Demonstration and Training, and the video file uploaded to the Missouri OA FMDC project management website, Trimble (fka eBuilder).

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 260573

SECTION 260583 – WIRING CONNECTIONS

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 SCOPE

A. The Contractor shall furnish and install all wiring connectors and terminations for 600-volt building wire, 600-volt multi-conductor control cable, 600-volt shielded instrumentation cable and CAT 6 Ethernet cable in low-voltage equipment and in medium-voltage equipment as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260533.16 – Boxes for Electrical Systems

E. Section 261326 – Medium-Voltage Fusible Load-Interrupter Switchgear

F. Section 261350 – Neutral Grounding Resistor

G. Section 262416 – Panelboards

H. Section 262419 – Motor Control Centers

I. Section 262816.16 – Enclosed Switches

J. Section 262912 – Motor Control

K. Section 263113.16 – Diesel-Engine-Driven Generator Set Controls

L. Section 263290 – Medium-Voltage Generator Connection Cabinet

M. Section 263623 – Medium-Voltage Automatic Transfer Switches

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each of the following items:

1. 600-volt connectors
2. 600-volt terminations and splices, including NEC 230.46 compliant splice connectors
3. 600-volt in-line splice insulating materials
4. 600-volt terminal blocks, including accessories

5. CAT 6 copper Ethernet connectors

PART 2 - PRODUCTS

2.1 600-VOLT CONNECTIONS AND TERMINATIONS

A. *Pressure Type Terminal and Splice Connectors:* Solderless, color coded, nylon insulated, pressure type, UL Listed 105°C, 600-volt, sized for the cable to be terminated or spliced, tin-plated copper, with crimping tool coded to the connectors with stops to prevent over-crimping and means to prevent under-crimping; 3M Scotchlok or approved equal.

B. *Spring Type Splice Connectors:* Solderless, color coded, flame retardant polypropylene and thermoplastic elastomer or flame retardant nylon, spin-on wings, spring steel inner spring with corrosion resistant coating, UL Listed 105°C, 600-volt, sized for splicing two or more conductors up to size #6 AWG; 3M Performance Plus or approved equal.

C. *Control Wiring Connections and Termination*: Control wiring connectors shall be vinyl or nylon pre-insulated spade lugs to match stud or screw size with insulation grip sleeve flared to prevent turned-back strands and crimping tool to crimp wire barrel and insulation sleeve.

1. Where attachment is to a terminal block screw or stud, install using pre-insulated ring type connectors.
2. Conductor to conductor splices shall be made using wire nuts or wing nuts only wrapped with a minimum of three (3) half-lapped layers of jacketing tape specified. No crimp type connectors shall be used for these types of splices.

D. *Power Connections, Terminations and Splice Connectors:*

1. Size 12 AWG through 2/0 AWG connectors shall be non-insulated, one-hole rectangular tongue, for copper conductors, UL Listed 90°C, 600-volt.
2. Size 3/0 AWG and larger conductors shall be non-insulated, two-hole rectangular tongue with long barrel length to permit two (2) crimps for copper conductors, UL Listed 90°C, 600-volt.
3. Feeder tap splices shall only be made where specifically indicated on the Drawings or where pre-approved by the Designer.
    a. Spring type splice connectors as specified herein. For size 6 AWG and smaller conductors only.
    b. Multiple tap mechanical type connectors for size range 12 AWG to 500 KCM. Burndy UNITAP Catalog No. BIBSxxxxDB or approved equal by Blackburn, Ilsco or Polaris.
    c. Multiple tap compression type connectors for size range 14 AWG to 750 KCM. Burndy “H” Shape Copper Tap Catalog No. YHxxxx with flame retardant cover or approved equal by Blackburn or Ilsco.
4. In-line splices shall only be made where specifically indicated on the Drawings or where pre-approved by the Designer.
    a. Size 12 AWG through 2/0 AWG connectors, for splicing like sized conductors, shall be non-insulated, standard length barrel, for copper conductors, UL Listed 90°C, 600-volt, compression type.

b. Size 3/0 AWG and larger connectors, for splicing like sized conductors, shall be non-insulated, long barrel length to permit two (2) crimps on each conductor, for copper conductors, UL Listed 90°C, 600-volt.

c. For splicing smaller copper conductors to larger copper conductors, utilize non-insulated, UL Listed 90°C, 600-volt, compression type kit with heat shrink insulating tube; Burndy Catalog No. YSRxxxxxxxxxKITC or approved equal by Blackburn or Ilsco.

E. *Power Termination and In-Line Splice Insulation:*

1. Provide pre-engineered cold shrink or heat shrink insulating kits by 3M, Raychem Corporation or Thomas & Betts.

2. For configurations or conductor sizes where pre-engineered insulating kits are not available provide insulating materials as follows:

a. Insulating Putty: 3M Scotchfil electrical insulating putty or approved equal by Thomas & Betts

b. Insulating Tape: 3M Scotch 23 or Thomas & Betts Shrink-Kon TBF201-36 self-fusing insulating tape

c. Jacketing Tape: 3M Scotch 33+ jacketing tape

F. *Terminal Blocks*:

1. DIN rail mounted, UL Listed, 600-volt, finger safe, high density modular style, compression type, IEC terminal blocks, rated for a minimum of 20 amps of AC current and sized as required based on the conductor sizes to be terminated.

2. Provide all required accessories to make a complete terminal block assembly. Accessories shall include but not be limited to:

a. DIN mounting rail (symmetrical aluminum)

b. End anchors (heavy-duty type)

c. End barriers

d. Center type jumper bars (Jumpering of live voltages using non-insulated comb type jumpers will not be acceptable.)

3. Each terminal on the terminal blocks shall be plainly and permanently marked with printer generated, plastic, snap-on markers. Wire labels shall not be used to identify terminals on terminal blocks.

4. Terminal block assemblies shall include 50% spare terminals of each size and type used. Terminal blocks shall be Allen-Bradley Bulletin 1492, W or J Series or approved equal by Schneider Electric, Phoenix Contact or Weidmueller.

2.2 CAT 6 COPPER ETHERNET CABLE CONNECTORS

A. RJ-45, 8-pin compression type with locking tab meeting the requirements of ANSI/TIA-568-C.2 with snag-proof strain relief, field installable connector compatible with the cable onto which installed.

PART 3 - EXECUTION

3.1 GENERAL

A. Conductors shall be continuous from source to destination without splices or taps in conduit runs, except where indicated on the Drawings to compensate for voltage drop or where required to prevent excessive pulling tension or sidewall pressure on wire or cable. Submit all proposed splice locations to the Designer for approval prior to pulling wire and cable. Where permitted, splices shall be mechanically strong and have an insulation value equal to the wire or cable being spliced. All splices and taps shall be contained within NEC sized junction boxes meeting the requirements of Section 260533.16 – Boxes for Electrical Systems.

B. Split-bolt connectors are not approved for any use other than connection of two (2) equipment grounding conductors or bonding jumpers in accordance with Specification Section 260526 – Grounding and Bonding for Electrical Systems.

3.2 CONTROL WIRING CONNECTIONS AND TERMINATIONS

A. Thoroughly clean wires before installing connectors.

B. Tape back spare conductors with the specified jacketing tape.

C. Where attachment is to a terminal block screw or stud, install using pre-insulated ring type connectors.

D. Where control cable terminations are split across terminal blocks or are otherwise separated by more than 12 inches distance, identify each conductor group with the circuit number as specified in Section 260553 – Identification for Electrical Systems.

E. Conductor to conductor splices shall be made using wire nuts or wing nuts. No crimp type connectors shall be used for these types of splices.

1. Apply a minimum of three (3) half-lapped layers of jacketing tape over each and every spring type (wire nut) splice connection.

F. Where a “splice” point is required in an instrument cable, provide an adequately sized hinged door box with inner back panel, per Section 260533.16 – Boxes for Electrical Systems, and IEC finger safe type DIN rail mounted terminal blocks as specified herein.

3.3 600-VOLT CONNECTIONS AND TERMINATIONS

A. Cut conductors to proper length such that the barrel or inner metal spring of the connector makes full contact with the bare conductor and not the insulation and the plastic skirt of the connector full covers the bare conductor.

1. Conductor to conductor splices for size 10 AWG or smaller conductors shall be made using wire nuts or wing nuts. No crimp type connectors shall be used for these types of splices.

2. Apply a minimum of three (3) half-lapped layers of jacketing tape over each and every spring type (wire nut) splice connection.

B. Power Connections and Terminations:

1. Cover all exposed live parts such as connectors, bolts, nuts, and bus bar with insulating material to equal or exceed insulation of the connected cable.

2. At equipment with cable leads such as motors, install compression type terminal connectors on equipment leads and power circuit leads, bolt together, and insulate with pre-engineered motor terminal kits or as specified herein.

3. At equipment with integral set screw or clamp type connectors such as terminal blocks and molded case circuit breakers, strip conductor insulation as required to clear contact surfaces, and torque connector in accordance with manufacturer's recommendations.

3.4 600-VOLT POWER TERMINATION AND IN-LINE SPLICE INSULATION

A. Insulate with pre-engineered cold shrink or heat shrink kits, or for configurations or conductor sizes were pre-engineered kits are not available, with a minimum of three (3) half-lapped layers of insulating tape covered with three (3) half-lapped layers of jacketing tape.

1. Provide electrical insulating putty to fill major irregularities and voids in termination prior to taping.

2. Apply self-fusing insulating tape directly to the conductors or over the electrical insulation putty.

3. Apply jacketing tape over the insulating tape to provide an outer covering for the cable termination.

3.5 CAT 6 COPPER ETHERNET CABLE TERMINATIONS

A. Utilize the connector manufacturer’s recommended installation tool(s) for cutting, stripping and crimping cable and inserting into the connector.

3.6 FIELD QUALITY CONTROL

A. General:

1. Testing shall be performed in the presence of Construction Representative. Contractor must provide 48 hours’ notice prior to conducting tests.

2. Prepare a test report upon completion of testing activities. Report format shall include the following information:

a. Summary of test results

b. Test equipment summary (model number, accuracy, calibration date)

c. Test personnel names and sign-offs

d. Completed data sheets

e. Test log and observations

f. Certificate of Compliance

B. Torque test conductor connections and terminations to manufacturer’s recommended values.

C. Provide testing for 600-volt wire and cable in accordance with Section 260519 – Low-Voltage Electrical Power Conductors and Cables in conjunction with the testing specified herein.

END OF SECTION 260583

SECTION 261316 – MEDIUM-VOLTAGE FUSIBLE LOAD-INTERRUPTER SWITCHGEAR

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 SCOPE

A. The Contractor shall furnish and install one (1) new medium-voltage fusible load-interrupter service entrance rated switchgear, pre-assembled, tested and fully integrated in an outdoor enclosure as shown on the Drawings and as specified herein.

B. Alternate Bid No. 1: The Contractor shall furnish and install one (1) new medium-voltage fusible load-interrupter switchgear pre-assembled, tested and fully integrated in an outdoor enclosure on the load side of the Section 263290 – Medium-Voltage Generator Connection Cabinet as shown on the Drawings and specified herein.

C. The Contractor shall provide all other equipment and services as required by this Specification.

1.3 RELATED SECTIONS

A. Section 033000 – Cast-In-Place Concrete

B. Section 260500 – Basic Electrical Requirements

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260553 – Electrical Identification

F. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

G. Section 263290 – Medium-Voltage Generator Connection Cabinet

1.4 SUBMITTALS

A. SUBMITTALS FOR REVIEW PRIOR TO PRE-FABRICATION: The Contractor shall prepare and submit to the Designer for review, prior to fabrication, shop drawings and descriptive literature for the switchgear including, but not limited to, the following:
(Allow a minimum of thirty (30) days in the construction schedule for Ameren review of the service entrance rated switchgear submittals.)

1. Master Drawing Index
2. Dimensioned Drawings: Front and side view elevations, floor plan, top view
3. Conduit Entry/Exit Locations
4. Single-Line Diagram

5. Electrical Schematic Diagram, including anti-condensation space heater and lightning (surge) arrester wiring
6. Nameplate Schedule
7. Component List/Bill of Materials
8. Assembly Ratings Including:
    a. Short-Circuit Rating
    b. Voltage
    c. Continuous Current
    d. Basic Impulse Level
9. Major Component Ratings Including:
    a. Voltage
    b. Continuous Current
    c. Interrupting Ratings
10. Cable Terminal Ratings
11. Descriptive Bulletins/Product Data Sheets:
    a. Lightning (surge) arresters
    b. Anti-Condensation Space Heaters
    c. Fusible Load-Interrupter Switch
    d. Power Fues
12. Seismic Certificate
13. Instruction Manuals

B. Switchgear submittals will not be approved until after the Protective Device Coordination and Arc Flash Analysis report specified in Section 260573 has been submitted for review.

C. SUBMITTALS FOR CONSTRUCTION: The Contractor shall prepare and submit the following items to the Designer for review for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.4 A that incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Certified production test reports
4. Installation information including equipment anchorage provisions
5. Seismic certificate
6. Installation, Operation and Maintenance Manual in compliance with Section 017823 – Operation and Maintenance Data and Section 007213 – General Conditions.

1.5 APPLICABLE STANDARDS

A. The switchgear covered by this section of the Specifications shall be designed, assembled and tested in accordance with the latest applicable ANSI, NEMA and NFPA standards, including, but not limited to:

1.	ANSI/IEEE	C37.20.3	IEEE Standard for Metal-Enclosed Interrupter Switchgear Rated Above 1 kV AC Up To and Including 48.3 kV AC
2.	ANSI/IEEE	C37.20.4	IEEE Standard for Indoor AC Switches (1 kV to 38 kV) for Use in Metal-Enclosed Switchgear
3.	ANSI/IEEE	C37.22	Preferred Ratings and Related Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear
4.	ANSI	C37.57	Switchgear - Metal-Enclosed Interrupter Switchgear Assemblies - Conformance Testing
5.	ANSI	C37.58	Switchgear - Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear - Conformance Test Procedures
6.	NFPA 70		National Electrical Code
7.	IBC		International Building Code
8.	Ameren Missouri CE-10		Specifications & Requirements for Multiple & Single Primary Metered Service

B. All components shall be UL Listed and Labeled, and the entire switchgear assembly shall be UL Listed and Labeled.

1.6 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of the equipment shall have produced similar electrical equipment for a minimum period of fifteen (15) years. When requested by the Designer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC) or latest California Building Code (CBC) with OSHPD Amendments, including OSHPD Special Seismic Certification (OSP) Pre-Approval.
2. See Paragraph 2.1 herein for site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards:

a. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment meets or exceeds the specified response spectra.

1.7 WARRANTY

A. All equipment furnished under this Section shall be guaranteed against defective parts and workmanship for a minimum of one (1) year from the date of substantial completion of the project. Any failures or deficiencies shall be corrected by the Contractor or the equipment supplier during the warranty period at no cost to the Owner.

1.8 DELIVERY AND HANDLING

A. Deliver and handle equipment in accordance with recommended practices listed in manufacturer's installation and maintenance manuals. One (1) copy of this manual shall be included with the equipment at time of shipment.

B. Schedule equipment delivery after housekeeping pad is completed so equipment can be lifted from delivery truck and immediately set into position on the pad.

C. Protect equipment from damage during shipment with shipping skids and weatherproof wrapping as required.

D. Inspect and report concealed damage to carrier within specified time.

1.9 EXTRA MATERIALS

A. Provide three (3) spare power fuse refill units of the type and size provided in the fusible load-interrupter switch.

B. Provide one (1) 12-ounce, minimum, aerosol can each of red-oxide or gray primer and the ANSI 49 or ANSI 61 gray topcoat paint for touching up scratches in the switchgear enclosure paint finish after installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. The switchgear described in this Specification shall be a single complete structure, metal-enclosed type, in an outdoor enclosure and intended for use on a 4,360Y/2,520 volt, 3-phase, 4-wire, solidly grounded, 60 hertz power system (for the service entrance rated switchgear) or 4,160 volt, 3-phase, 3-wire, solidly grounded, 60 hertz power system (for the Alternate Bid No. 1 switchgear on the load side of the Section 263290 – Medium-Voltage Generator Connection Cabinet as shown on the Drawings and specified herein).

B. The entire switchgear assembly including fusible load-interrupter switch, surge arresters, anti-condensation space heaters, etc., shall be completely factory-built, assembled, wired and tested. All equipment and components shall be of new construction.

C. The switchgear enclosure shall be designed to be fastened to an outdoor, grade mounted concrete equipment pad using an approved means of fastening.

D. Design Parameters:

1. Site elevation ..... 880 ft.
2. Site design air temperature range..... -20°F to 110°F
3. Location ..... Outdoors

E. Design Loads:

1. The entire switchgear assembly, as well as the means of fastening to the concrete equipment pad, shall be capable of withstanding gravity, operating, wind, snow, ice, rain, and seismic loads.
2. The latest editions of the International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures shall be used as the design code with the specific environmental factors as stated below.
3. Comply with the ASCE Hazards Report for site included as Attachment 1 to Section 260500 – Common Work Results for Electrical.
4. Minimum Design Wind Speed: 120 mile per hour
5. Earthquake Design Data:
   a. Occupancy Classification:
      1) Power Plant: Moderate-hazard factory industrial, Group F-1
      2) Correctional Center: Institutional Group I-3, Condition 5
   b. Risk Category: IV
   c. Seismic Importance Factor: Ie = 1.5
   d. Site Class: D
   e. Mapped Spectral Response Accelerations: Ss = 0.23, S1 = 0.1
   f. Spectral Response Coefficients: SDS = 0.2, SD1 = 0.14
   g. Seismic Design Category: D
   h. Component Amplification Factor: $A_p = 2.5$
   i. Component Response Modification Factor: $R_p = 2$
   j. Overstrength Factor: $\Omega_o=2$
   k. Analysis Procedure: Equivalent Lateral Force ASCE 7

2.2 RATINGS

A. Switchgear assembly ratings shall be as follows:

1. Nominal System Voltage: 4.36Y/2.52 kV, 3PH, 4W
   No Neutral Bus in Swgr
   (Service Entrance Rated Swgr)

		4.16 kV, 3PH, 4W (Alternate Bid No. 1 Swgr)
2.	System Grounding:	Solid
3.	Main Cross Bus Continuous Current:	1200 A
4.	Main Cross Bus Momentary Current:	40 kA RMS Asymm (10-cycle)
5.	Main Cross Bus 2-Second Current:	25 kA RMS Symmetrical
6.	Maximum Design Voltage:	4.76 kV
7.	Basic Impulse Level (BIL):	60 kV
8.	Main Cross Bus Momentary Current (10 Cycle):	40 kV RMS Asymmetrical
9.	Main Cross Bus 2-Second Short Circuit Current:	25 kA RMS Symmetrical
10.	Non-Fused Switch (Continuous and Load Break):	1200 A
11.	Non-Fused Momentary Withstand:	40 kA RMS Asymmetrical
12.	Non-Fused Switch Fault Close (3X, Minimum):	40 kA RMS Asymmetrical
13.	Non-Fused Switch 2-Sec Short Circuit Current:	25 kA RMS Symmetrical
14.	Type of Fuse:	RBA800
15.	Fuse Interrupt Rating:	25 kA RMS Symmetrical
16.	Fuse Rating:	As indicated on the Drawings
17.	Fused Switch Fault Close:	40 kA RMS Asymmetrical

2.3 CONSTRUCTION

A. The switchgear shall consist of a single dead-front, completely metal-enclosed vertical section containing a load-interrupter switch and refillable boric acid expulsion or solid material type power fuses of the number, rating and type noted on the Drawings or specified herein.

B. The following features shall be supplied in the single vertical section with three-pole, two-position open-closed switch:

1. A minimum 8-inch x 16-inch high-impact viewing window that permits full view of the position of all three switch blades through the closed door. The window shall be not more than 58 inches above the bottom of the switchgear to allow ease of inspection.

2. The door shall be interlocked with the switch such that:

   a. The switch must be opened before the door can be opened.

   b. The door must be closed before the switch can be closed.

3. A hinged grounded metal barrier that is bolted closed in front of the switch to prevent inadvertent contact with any live part yet allows for a full-view inspection on the switch blade position.

4. Provision for padlocking the switch in both the open and closed positions.

5. Green OPEN, Red CLOSED switch position indicators with the words “OPEN” and “CLOSED” in English.

6. A pad-lockable hinged cover with rustproof quarter turn nylon latches shall be provided over the switch operating mechanism to prevent unauthorized operation of the switch.

7. The switch shall be removable from the structure as a complete operational component.

C. Vertical section construction shall be of the universal frame type using die-formed and bolted parts. All enclosing covers and doors shall be fabricated from steel whose thickness shall be equal to or greater than those specified in ANSI/IEEE C37.20.3. No end-user removable hardware for covers or doors shall be thread-forming type. No fasteners for internal components shall be accessible from the exterior of the switchgear enclosure.

D. *Rear Door*: To facilitate installation and maintenance of cables and bus in the vertical section, a single full-height and full-width, hinged rear door with three-point latch with pad-lockable handle shall be provided. Opening the door shall not require the removal of bolts of any kind.

E. *Front Door*: The vertical section shall have a single, full-height and full-width, flanged front door, with three-point latch with pad-lockable handle. Opening the door shall not require the removal of bolts of any kind. Provisions shall be made for operating the switch and storing the removable handle with the full-height door closed and latched.

F. A G90 grade galvanized base shall isolate equipment from contact with the concrete pad providing protection from rust. Heavy-duty hot dipped galvanized anchor clips shall be provided to anchor the switchgear to the concrete pad or else the bottom frame of the equipment shall be furnished with a mounting hole at all four interior corners for installation of expansion anchor bolts.

G. Each load interrupter switch shall have the following features:

1. Three-pole gang-operated mechanism.

2. Manual quick-make, quick-break over-toggle-type mechanism that does not require the use of a chain or a cable for operation and utilizes a heavy-duty coil spring to provide opening and closing energy.

3. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation.

4. Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty.

5. Insulating barriers between each phase and between the outer phases and the enclosure.

6. A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the arc interrupting contacts.

2.4 BUS

A. All phase bus conductors shall be silver-plated copper.

B. The ground bus shall be silver-plated copper and be directly fastened to a galvanized metal surface at the bottom of each vertical section and shall extend the full width of the

enclosure. The ground bus shall be of a size sufficient to carry the rated (2-second) current of the switchgear assembly.

C. A neutral bus is not required and shall not be provided.

D. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

E. The switchgear buses shall be arranged so that phases A, B, C are from top to bottom, front to back, and left to right when viewing from the front of the switchgear.

2.5 BUS INSULATION SYSTEM

A. All bus shall be supported utilizing a high strength and high creep, support providing a minimum of 10.5-inch creep distance between phases and ground. The molded fins shall be constructed of high track resistant polyester or cycloaliphatic epoxy.

B. All standoff insulators on switches and fuse mountings shall be of high track resistant fined polyester or cycloaliphatic epoxy.

2.6 CABLE COMPARTMENT

A. The incoming cable compartment shall have adequate cable-training space. There shall be a minimum 36” vertical clearance between the point of cable entry and the point of cable termination.

B. There shall not be any obstructions inside the incoming cable compartment that could adversely affect the installation, termination or landing of the medium voltage cables.

C. The incoming cable compartment shall not house ground fault sensing current transformers (GFCT) through which the incoming cables extend. GFCT's are not allowed in the incoming cable compartment.

D. The incoming cable compartment shall include a cable support bar (non-conductive material), located approximately half way between the cabinet floor and the main bus utility cable termination lugs (Y-plane) and approximately the same distance from the rear door as the main bus utility cable termination lug (X-plane).

E. Sufficient space shall be allowed below each cable connection for 15 kV Class 1 cable terminators with skirted stress cones. Incoming and outgoing cables shall enter and exit from the bottom of the switchgear.

F. Sufficient space shall be provided for installation of lightning (surge) arresters as specified herein.

2.7 GROUNDING REQUIREMENTS FOR SERVICE ENTRANCE SWITCHGEAR

A. The requirements of this Article 2.7 do not apply to the Alternate Bid No. 1 medium-voltage fusible load-interrupter switchgear on the load side of the Section 263290 – Medium-Voltage Generator Connection Cabinet.

B. The incoming cable compartment shall have a 5/8” diameter x 4” long grounding stud rigidly attached to each phase of the incoming line/bus. The grounding studs shall be suitable for the attachment of a C-clamp style grounding clamp. Ameren does not use ball

type grounding clamps. For example, a Hubbell-Chance model T600-2364 or similar type stud is acceptable but a Hubbell-Chance model C600-2102 is not acceptable.

C. Phase bus grounding studs shall be vertically oriented pointing upward or horizontally oriented to the side. The studs shall not point outward or inward from the bus.

D. Phase bus grounding studs shall be located such that they can be reached from ground level by someone standing or kneeling on the ground.

E. Phase bus grounding studs shall be located such that no connections are made above or near energized components. Provide protective insulting barriers if/as required to ensure that this requirement is met.

F. Phase bus grounding studs shall meet the following requirements:

1.	Material:	Tin-Plated Copper
2.	Bus Attachment Means:	2¾" threaded shank w/ ½"-13 UNC
3.	Current Rating:	400 A
4.	15-Cycle Fault Current Rating:	43,000 A
5.	30-Cycle Fault Current Rating:	30,000 A
6.	Design and Testing Standard:	ASTM F855 Grade 5

G. Provide a grounding stirrup or bail connected to the switchgear ground bus at the bottom of the incoming cable compartment suitable for landing three (3) grounding clamps; 1 connected to the grounding stud on each phase bus. The grounding stirrup/bail shall be situated such that three (3) grounding clamps can be installed with sufficient space to allow the cubicle door to be latched shut.

H. The grounding stirrup/bail shall meet the following requirements:

1.	Material:	Tin-Plated Copper
2.	Ground Bus Attachment Means:	2-Hole, Rectangular Tongue, Long-Barrel Copper Compression Lugs or Other Means Acceptable to the Designer
3.	Current Rating:	400 A
4.	15-Cycle Fault Current Rating:	43,000 A
5.	30-Cycle Fault Current Rating:	30,000 A

2.8 POWER WIRING TERMINATIONS

A. One (1) terminal pad per phase, with factory NEMA hole drilling, shall be provided for attaching Contractor-supplied two-hole long-barrel copper compression type cable terminal lugs for a maximum of three (3) conductors per phase of the sizes indicated on the Drawings on both the line and load sides of the fusible load-interrupter switch. Sufficient space shall be allowed for Contractor-supplied electrical stress relief termination devices.

2.9 CONTROL WIRING/TERMINATIONS

A. Small wiring, fuse blocks and terminal blocks within the vertical section shall be furnished as required.

B. The switchgear wiring shall be Type SIS, flexible 41-strand minimum, copper, 90°C dry, 600-volt single conductor wire, minimum size 14 AWG. All wire shall be flame-retardant meeting Underwriters' Laboratories, Inc. VW-1 vertical flame test.

C. All electrical devices installed in a vertical section shall be factory wired to terminal blocks located inside the vertical section. Interconnecting wiring from exterior components to the switchgear shall terminate at the terminal blocks.

D. Terminal blocks shall be provided for the connection of all interconnection wiring leaving the switchgear and going to all remote devices and 120VAC power source for anti-condensation heaters.

E. A minimum of ten percent (10%) spare terminal blocks shall be provided.

F. All terminal blocks shall contain a white or very light gray center mounted removable marking strip.

G. Conductors shall be identified at each termination by marking with a number to correspond with the wiring diagrams. Identification tags shall be made of oil-resistant material. If wrap-type adhesive strips are used, they shall be a minimum of 1-3/8 inches long. Sleeve-type tags shall be undersized so that they will not slip off the conductor if the conductor is removed from its termination point. Identification tags shall be W.H. Brady Company Type B-700, or T & B WSL Series, or approved equal.

H. All wiring for the 120VAC power source for anti-condensation heaters and for remote control devices shall enter/exit the switchgear through the bottom.

2.10 POWER FUSES

A. Fault protection shall be provided by refillable boric acid expulsion or solid material type power fuses with blown fuse indication. Fuses shall have continuous ampere ratings as shown on the Drawings and/or as specified herein.

B. Any fuse/switch integrated momentary and fault close ratings specified shall have been verified by test and UL certified.

C. Furnish three (3) spare fuse refill units in a metal “pocket” on the inside of the fusible load-interrupter switch door. Protect fuses with heavy plastic wrap or by placing in a heavy zip-top plastic bag before placing in the door pocket of the switchgear.

2.11 ENCLOSURE

A. Enclosures shall be constructed per IEEE/ANSI C37.20.3 Outdoor specifications. (Exceeds NEMA 3R.) The design shall be non-walk-in type.

B. Each vertical section shall have a sloped weatherproof roof with labyrinth shaped joints. Use of gasket or caulking to make roof joints weatherproof shall not be permitted. All exterior openings shall be screened to prevent the entrance of small animals and barriered to inhibit the entrance of snow, sand, etc.

C. Two (2) 150-watt (minimum), 120VAC anti-condensation space heaters shall be provided in each vertical section. Heaters shall be factory wired to terminal blocks for connection of 120VAC power circuit conductors from a remote power source as indicated on the

Drawings. A thermostat shall not be provided. Provide a warning label on the switchgear indicating that the heaters are powered from a remote source.

D. Each vertical section shall be ventilated at the top and bottom, both front and rear, to allow airflow to provide cooling and help prevent buildup of moisture within the structure.

E. Enclosure shall be dust resistant. All ventilated openings shall be filtered to inhibit the ingress of dust. The ventilated covers shall be externally removable to allow safe maintenance of the filter media without providing access to live parts. All external doors and covers shall be gasketed.

F. Provide removable lifting eyes on the enclosure for handling the switchgear by crane.

2.12 FINISH

A. Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils. The finish shall have the following properties:

1.	Impact resistance (ASTM D-2794)	60 direct/60 indirect
2.	Pencil hardness (ASTM D-3363)	H
3.	Flexibility (ASTM D-522)	Pass 1/8-inch mandrel
4.	Salt spray (ASTM B117-85 [20])	600 hours
5.	Color	ANSI 61 gray

2.13 NAMEPLATES AND COMPONENT LABELING

A. A nameplate shall be mounted on the front door of each switch vertical section in accordance with the Drawings. Nameplates shall be laminated plastic, black characters on a white background. Characters shall be 3/16-inch high, minimum.

B. Control components mounted within the assembly, such as fuse blocks and anti-condensation heaters, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams. Provide a warning label on the switchgear indicating that the space heaters are powered from a remote source.

C. Additional engraved laminated plastic nameplates required for the service entrance rated switchgear.

1. 1/2-inch high (minimum) white characters on a red background: "MAIN SERVICE DISCONNECT" installed on exterior front of switchgear enclosure next to load-interrupter switch operator.

2. 3/8-inch high (minimum) black characters on a black background: "LOCKABLE VISIBLE OPEN DISCONNECT FOR ISOLATION FROM GENERATOR" installed on exterior front of switchgear enclosure below the switch blade viewing window.

2.14 SURGE PROTECTION

A. *Lightning (Surge) Arresters:* One metal-oxide type heavy-duty, intermediate class lightning (surge) arrester rated 5.1 kV maximum continuous line-to-ground operating

voltage (MCOV) (6 kV RMS Duty Cycle Voltage rating) shall be provided on each 4.16 kV phase conductor on the line side terminals of the load-interrupter switch and shall be mounted in the cable compartment at the bottom of the switchgear.

1. Surge arresters shall be fabricated from ESP silicone alloy weathershed material, Hubbell Power Systems – Ohio Brass Type PVI-LP, or approved equal by Cooper Power Systems or Eaton.
2. Surge arrestors connected to the incoming cable in service entrance rated switchgear shall have connections that are removable with a hot stick. This is typically accomplished by connecting the surge arrestors to a ground stud using flexible conductor and a hot line clamp. The grounding studs may be the same ones as specified herein for grounding the phase buses.

2.15 ACCEPTABLE MANUFACTURERS

A. The medium-voltage fusible load-interrupter switchgear shall be manufactured by:

1. ABB
2. Eaton
3. Square D
4. S&C Electric

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Products in compliance with the specification and manufactured by others not named will be considered for approval only if a properly completed Product Substitution Request form, Section 006325 – Substitution Request, is submitted to the Designer, along with all supporting data necessary for evaluation of the product, at least five (5) days prior to bid date in accordance with Section 012500 – Substitution Procedures.

2.16 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests be in accordance with the latest version of ANSI and NEMA standards.

B. The manufacturer shall provide a certified electronic copy of factory test reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and as indicated on the Contract Drawings.

B. The conduit entrance into the incoming cable compartment shall be physically aligned with the connections to the associated bus work.

C. Provide an outdoor concrete equipment pad in accordance with the Contract Documents.

D. Set the switchgear in the proper location and orientation on the concrete pad. Do not slide the equipment on the concrete pad to avoid damaging the protective finish on the bottom of the equipment.

E. Secure the switchgear to the concrete pad with stainless steel expansion anchor bolts in accordance with the manufacturer's instructions and Section 260529 – Hangers and Supports for Electrical Equipment.

F. The Contractor shall terminate all power cables and control wiring within the switchgear enclosure.

G. Prep and touch-up all blemishes and scratches in the factory finish on the enclosure in strict accordance with the equipment manufacturer's instructions using primer and touch-up paint provided by the equipment manufacturer.

3.2 FIELD TESTING

A. Final acceptance testing for the switchgear shall include phase-to-phase and phase-to-ground resistance measurements (meggering) of all power voltage terminals. The resistance reading between each terminal and ground shall be a minimum of 200 megohms.

3.3 FIELD SERVICE ASSISTANCE

A. The Contractor shall provide a qualified factory-trained manufacturer's representative to certify in writing that the equipment and interconnection wiring has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. All items shall be visually inspected to ascertain that each item is not damaged and is in proper working condition.

C. The Contractor shall provide a signed and dated electronic copy of the manufacturer's certification.

D. All discrepancies shall be immediately corrected by the Contractor, either by repairing or replacement, to the satisfaction of and at no cost to the Owner. Final payment of the Contract shall be withheld until this has been accomplished.

E. Any changes made during startup and commissioning of the equipment shall be included on the "as-built" record drawings to be submitted within two weeks of the successful completion of startup and testing.

3.4 TRAINING

A. Provide on-site training in accordance with Section 017900 – Demonstration and Training to instruct the Owner's personnel in the proper operation and routine maintenance of the equipment. Review operation and maintenance manuals, parts manuals and emergency service procedures.

B. The training shall be conducted by a manufacturer's qualified representative, after completion of the acceptance testing, and shall consist of instruction on the assembly, switches and major components. The training session shall be video recorded by the Contractor in accordance with Section 017900 – Demonstration and Training, and the video file uploaded to the Missouri OA FMDC project management website, Trimble (fka eBuilder).

END OF SECTION 261316

SECTION 261350 – NEUTRAL GROUNDING RESISTOR

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 SCOPE

A. The Contractor shall furnish and install the neutral grounding resistor as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 033000 – Cast-In-Place Concrete

B. Section 260500 – Common Work Results for Electrical

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260553 – Identification for Electrical Systems

F. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

G. Section 263623 – Medium-Voltage Automatic Transfer Switches

1.4 SUBMITTALS

A. The Contractor shall prepare and submit to the Designer for approval, prior to fabrication, shop drawings and descriptive literature on the neutral grounding resistor including, but not limited to, the following:

1. Front view elevation
2. Floor plan
3. Top view
4. Wiring Diagrams
5. Conduit entry/exit locations
6. Cable terminal sizes
7. Assembly ratings including:
    a. Line-to-ground voltage rating
    b. Rated ampacity and time duration
    c. Enclosure type and material
8. Product data sheets for all components including the current transformer.

B. Neutral grounding resistor submittals will be provided to the Section 260573 Protective Device Coordination Study and Arc Flash Risk Assessment engineer and will not be returned to the neutral grounding resistor supplier until after receipt of the Protective Device Coordination Study and Arc Flash Risk Assessment report confirming the ampere rating required for the neutral grounding resistor.

C. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.4 A. that incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Certified production test reports
4. Installation information
5. Seismic certification and anchorage details as specified
6. Installation, Operation and Maintenance Manual in compliance with Section 017823 – Operation and Maintenance Data and Section 007213 – General Conditions

1.5 APPLICABLE STANDARDS

A. The neutral grounding resistor shall be designed and factory tested to:

1. IEEE 32 – IEEE Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices
2. ANSI/IEEE C57.13 – IEEE Standard Requirements for Instrument Transformers

B. All components shall be UL Listed and Labeled, and the entire neutral grounding resistor assembly shall be UL Listed and Labeled.

1.6 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of fifteen (15) years. When requested by the Designer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. Provide seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC) or latest California Building Code (CBC) with OSHPD Amendments, including OSHPD Special Seismic Certification (OSP) Pre-Approval. If a prototype unit has not been shake table tested, then compliance by calculations will be acceptable.
2. See Paragraph 2.1 herein for site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards:

a. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment meets or exceeds the specified response spectra.

1.7 WARRANTY

A. All equipment furnished under this Section shall be guaranteed against defective parts and workmanship for a minimum of one (1) year from the date of substantial completion of the project. Any failures or deficiencies shall be corrected by the Contractor or the equipment supplier during the warranty period at no cost to the Owner.

1.8 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.9 EXTRA MATERIALS

A. Provide one (1) 12-ounce, minimum, aerosol can each of red-oxide or gray primer and the ANSI 49 or ANSI 61 gray topcoat paint for touching up scratches in the neutral grounding resistor enclosure paint finish after installation, unless the enclosure is stainless steel.

PART 2 - PRODUCTS

2.1 GENERAL

A. The grounding resistor(s) shall be as follows:

Initial Current rating: .....250 amperes
System/Line-to-ground voltage rating: ..... 4.16Y/2.4 kV
Time rating:..... 10 seconds
Temperature rise: ..... 760°C rise

B. Resistor units shall have double insulated stainless steel stamped grid elements. Resistor terminals shall be stainless steel. All resistor end frames, hardware, and non-current carrying spacers shall be zinc-plated steel.

C. The neutral ground resistor shall be provided with an outer safety enclosure. The enclosure shall have a solid top with eye bolts to aid in handling, a screened bottom, and solid side covers with louvers or screens, if/as required for cooling. The enclosure shall be mill galvanized steel, aluminized steel, aluminum or stainless steel. All enclosure types, except stainless steel, shall be furnished with a factory power coat ANSI 49 or ANSI 61 paint finish.

D. Minimum enclosure rating shall be NEMA Type 3R.

E. Provisions shall be provided for mounting the current transformer, specified herein, inside the neutral grounding resistor enclosure.

F. The neutral grounding resistor enclosure shall be designed to be fastened to an outdoor, grade mounted concrete equipment pad using an approved means of fastening.

G. Design Parameters:

1. Site elevation ..... 880 ft.
2. Site design air temperature range..... -20°F to 110°F
3. Location ..... Outdoors

H. Design Loads:

1. The entire neutral grounding resistor assembly, as well as the means of fastening to the concrete equipment pad, shall be capable of withstanding gravity, operating, wind, snow, ice, rain, and seismic loads.
2. The latest editions of the International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures shall be used as the design code with the specific environmental factors as stated below.
3. Comply with the ASCE Hazards Report for site included as Attachment 1 to Section 260500 – Common Work Results for Electrical.
4. Minimum Design Wind Speed: 120 mile per hour
5. Earthquake Design Data:
   a. Occupancy Classification:
      1) Power Plant: Moderate-hazard factory industrial, Group F-1
      2) Correctional Center: Institutional Group I-3, Condition 5
   b. Risk Category: IV
   c. Seismic Importance Factor: Ie = 1.5
   d. Site Class: D
   e. Mapped Spectral Response Accelerations: Ss = 0.23, S1 = 0.1
   f. Spectral Response Coefficients: SDS = 0.2, SD1 = 0.14
   g. Seismic Design Category: D
   h. Component Amplification Factor: Ap = 2.5
   i. Component Response Modification Factor: Rp = 2
   j. Overstrength Factor: Ωo = 2
   k. Analysis Procedure: Equivalent Lateral Force ASCE 7

2.2 MANUFACTURERS

A. Approved manufacturers:

1. ASCO
2. Bender
3. Eaton

4. I-Gard

5. Post Glover

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Products in compliance with the specification and manufactured by others not named will be considered for approval only if a properly completed Product Substitution Request form, Section 006325 – Substitution Request, is submitted to the Designer, along with all supporting data necessary for evaluation of the product, at least five (5) days prior to bid date in accordance with Section 012500 – Substitution Procedures.

2.3 CURRENT TRANSFORMER

A. Provide a current transformer mounted inside the neutral grounding resistor enclosure for field wiring back to the generator protection relay in the medium-voltage automatic transfer switch per Section 263623 – Medium-Voltage Automatic Transfer Switches for tripping the generator breaker when the current flow through the current transformer exceeds the trip setting of the relay.

B. *Core and Coil Construction*: The core shall be made from high quality grain-oriented silicon steel, annealed under rigidly controlled factory conditions. The primary winding shall consist of two coils in series, one around each leg of the core to minimize flux leakage and thus improving the accuracy of the transformer. The secondary winding shall consist of two coils in parallel with each coil located inside the corresponding primary coil and surrounding one leg of the core.

C. *Core and Coil Encapsulation*: The core and coil assembly shall be encapsulated in vacuum cast polyurethane resin to provide excellent electrical and mechanical properties over a wide temperature range with low water absorption and resistance to oil and a variety of chemicals.

D. *Primary Bars*: The primary terminals shall be tin-plated copper bars molded into the cast resin insulation with one hole and one slot at each end, suitable for ½" bolts.

E. *Terminals*: Secondary terminals shall be tin-plated brass, compression type with a 0.275" diameter cross-hole for wiring a 1/4-28 clamp screw. A shorting device shall be provided and interlocked to the terminal cover that is made of clear plastic. Provisions shall be provided for sealing the cover.

F. *Polarity:* A white polarity dot and primary and secondary markers H1 and X1, shall be permanently molded in the insulation such that they are integral parts of the current transformer and cannot be readily obliterated.

G. *Nameplate*: A laser engraved aluminum or stainless-steel nameplate shall be attached to the top of the current transformer. The nominal current rating shall be marked on the side of the current transformer in large numerals.

H. *Base Plate and Mounting*: A stainless-steel base plate shall be provided and shall have four (4) slots for mounting inside the neutral grounding resistor enclosure. The current transformer shall be suitable for mounting in any orientation.

I. The current transformer specifications shall be as follows:

1.	Voltage:	5 kV
2.	Basic Impulse Level (BIL):	60 kV
3.	Frequency:	60 Hz
4.	Construction Type:	Bar Type - Wound Primary
5.	Current Ratio:	250:5
6.	ANSI Meter Class Burden:	0.3
7.	Relay Class:	T100
8.	Continuous Thermal Current Factor:	1.5 @ 30°C Amb., 1.0 @ 55°C Amb.
9.	Primary Bar Size:	2” wide X 0.25” thick
10.	1-Second Thermal Limit:	25,700 A
11.	Mechanical Limit:	33,000 A
12.	Environment:	Inside a NEMA 3R outdoor weatherproof enclosure

J. Acceptable Manufacturers:

1. GE-Vernova Model JKM-3C
2. Approved equal by ABB or Flex-Core

2.4 ACCESSORIES

A. Base insulators

B. Entrance bushings and terminal lugs

C. Stand for outdoor grade mounting to a concrete equipment pad

2.5 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment provided under this section. The neutral ground resistor shall conform to IEEE Standard 32.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

2.6 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed in accordance with the manufacturer’s recommendations.

B. The Contractor shall provide three (3) copies of the manufacturer’s representative’s certification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and as indicated on the Contract Drawings.

B. Place the neutral grounding resistor into its final location on a new grade mounted concrete equipment pad as shown on the Drawings. Bolt the enclosure to the concrete pad using expansion anchor bolts meeting the requirements of Section 260529 – Hangers and Supports for Electrical Equipment. Anchor bolt size, quantity and placement shall be as indicated in the equipment manufacturer's installation instructions for seismic certification.

C. The Contractor shall terminate all wiring, including current transformer wiring, within the neutral grounding resistor enclosure.

D. Prep and touch-up all blemishes and scratches in the factory finish on the enclosure in strict accordance with the equipment manufacturer's instructions using primer and touch-up paint provided by the equipment manufacturer.

END OF SECTION 261350

SECTION 262416 – PANELBOARDS

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 SCOPE

A. The Contractor shall furnish and install all circuit breaker panelboards as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 230900 – Instrumentation and Control for HVAC

B. Section 260500 – Common Work Results for Electrical

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.13 – Conduit for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

G. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

H. Section 260583 – Wiring Connections

1.4 SUBMITTALS

A. Manufacturer's product data sheet and shop drawing shall be submitted for each circuit breaker panelboard, including the circuit breakers and surge protective device (SPD).

B. Panelboard shop drawings shall include, but not be limited to, the following:

1. Outline drawings including the overall panelboard enclosure dimensions, interior mounting dimensions and wiring gutter dimensions.
2. The location of the circuit breakers, neutral and equipment ground buses and SPD.
3. Type and ratings of all circuit breakers.

C. Seismic equipment certification and equipment anchorage details for all panelboards.

D. The following submittals shall be provided for each panelboard surge protective device (SPD):

1. Provide verification that the SPD unit complies with the required UL 1449, Fourth Edition and UL 1283 surge voltage rating (SVR).

2. Provide actual let through voltage test data in the form of oscillograph results for both the ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (ringwave) tested in accordance with ANSI/IEEE C62.45.

3. Provide test report from a nationally recognized independent testing laboratory verifying the SPD components can survive published surge current rating on both a per mode and per phase basis using the IEEE C62.41, 8 x 20 microsecond current wave. Test data on individual module is not acceptable.

4. Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying the device's noise attenuation exceeds 44 dB at 100 kHz.

5. Provide test report from a nationally recognized independent testing laboratory verifying the SPD overcurrent protection will allow the rated maximum surge current to pass through the device without fuse operation.

6. Provide life cycle testing certification.

7. Provide an equipment manual that includes but is not limited to spare parts lists and operating instructions for the specified SPD unit.

8. SPD warranty certificate

1.5 REFERENCED STANDARDS

A. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

B. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

C. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

D. National Electrical Code: Article 242

E. National Electrical Code: Article 408

F. UL 67 – Panelboards

G. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

H. UL 1283 – Electromagnetic Interference Filters

I. UL 1449, 4th Edition – Surge Protective Devices

1.6 QUALIFICATIONS

A. The manufacturer of the panelboard assemblies shall be the manufacturer of the major components within each assembly.

B. Provide equipment that is IBC/CBC seismically qualified with seismic certification label.

1.7 LISTING REQUIREMENTS

A. Panelboards shall bear the UL Mark and shall be listed to the most recent edition of UL 67.

B. SPD shall bear the UL Mark and shall be listed to the most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL listing and does not meet the intent of this specification.

C. Provide an IBC/CBC seismic certification label on each panelboard enclosure.

1.8 QUALITY ASSURANCE

A. All panelboards shall be tested at the factory for compliance with all applicable codes and standards and shall be ready for installation when received at the project site.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKER PANELBOARDS

A. Circuit breaker panelboards must be of panelboard type construction. Load centers are not acceptable.

B. Circuit breaker panelboards shall be dead front safety type equipped with circuit breakers. Each panelboard, including all bus bracing, shall have an integrated short circuit withstand rating equal to the short circuit interrupting capacity of the circuit breakers. All panelboards shall be fully rated. Series rated panelboards are not acceptable. Panelboard bus structure and main lugs or main breaker shall have current and voltage ratings, number of phases, poles and number of wires and short circuit current rating as indicated on the Drawings.

C. Panelboard enclosures shall be fabricated from code gauge galvanized steel constructed in accordance with UL 50 requirements.

D. All panelboard enclosures shall be surface mounted, fabricated from cold-rolled galvanized steel. Each panelboard shall have an outer door and an inner door, both equipped with a locking handle requiring a milled key. The doors and frame shall be coated on all sides with rust-inhibiting primer and finished with the appropriate number of coats of ANSI-61 or ANSI-49 gray baked-on enamel paint. At least one key shall be provided with each panelboard, and all panelboard locks shall be keyed alike. The inner door shall provide access to only the circuit breakers, while the outer door shall be secured to the edge of the enclosure with a continuous hinge from top to bottom to provide access to the panelboard wiring gutters. All panelboard enclosures shall be NEMA Type 12, door-in-door.

E. The panelboard assembly shall be designed to be fastened to a concrete equipment pad on a concrete floor and/or the wall behind the panelboard.

F. Design Parameters:

1. Site elevation ..... 880 ft.
2. Site design air temperature range..... 40°F to 100°F
3. Location ..... Indoors

G. Design Loads:

1. The entire panelboard assembly, as well as the means of fastening to the concrete equipment pad/floor below the concrete equipment pad and/or the building, shall be capable of withstanding gravity, operating, and seismic loads.
2. The latest editions of the International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures shall be used as the design code with the specific environmental factors as stated below.
3. Comply with the ASCE Hazards Report for site included as Attachment 1 to Section 260500 – Common Work Results for Electrical.
4. Earthquake Design Data:
    a. Occupancy Classification:
        1) Power Plant: Moderate-hazard factory industrial, Group F-1
        2) Correctional Center: Institutional Group I-3, Condition 5
    b. Risk Category: IV
    c. Seismic Importance Factor: Ie = 1.5
    d. Site Class: D
    e. Mapped Spectral Response Accelerations: Ss = 0.23, S1 = 0.1
    f. Spectral Response Coefficients: SDS = 0.2, SD1 = 0.14
    g. Seismic Design Category: D
    h. Component Amplification Factor: $A_p = 2.5$
    i. Component Response Modification Factor: $R_p = 2$
    j. Overstrength Factor: $\Omega_o=2$
    k. Analysis Procedure: Equivalent Lateral Force ASCE 7

H. A framed directory card with a clear plastic covering shall be provided on the inside of the inner door. The directory card shall be in accordance with Section 260553 – Identification for Electrical Systems.

I. All panelboard interiors shall be equipped with bus bars and adjustable means for positioning the interior within the enclosure to ensure the dead front fits snuggly over the circuit breakers.

J. All bus bars shall be silver-plated copper and shall be made all from the same material. All plating shall be done electrolytically and shall cover the entire length of bus. Plating must be not less than 0.003-inch thick and shall cover both sides and all edges of each bus bar. Aluminum bus bars will not be acceptable.

K. All phase and neutral bus bar conductors shall be fabricated from 1000A/in^2 current density rated Oxygen Free High Conductivity (OFHC) Copper 102, being 99.95 per cent pure copper and having an average annealed conductivity of 101 per cent IACS. Copper bus bar conductors shall be hard-drawn temper and shall meet the requirements of ASTM Specifications B 187. Neutral bus bar conductors shall be insulated from the panelboard and shall be the same size as the phase bus bar conductors.

L. Bus bars shall extend the full height of the available space for mounting future circuit breakers.

M. The panelboard interior shall be provided with a copper ground bus bar conductor(s) equal to at least 25% ampacity of the phase bus bar conductors, which shall be bonded to the panelboard enclosure.

N. The neutral bus bar conductor and the ground bus bar conductor shall each be provided with an individual terminal or lug for each wire connected to it.

O. The neutral bus bar and the ground bus bar shall not be electrically bonded together.

P. The location of the main terminations, top or bottom, shall be determined by the entrance of the incoming power feeder conductors to the panelboard enclosure.

Q. Provide molded case main circuit breaker with electronic trip unit or UL listed main lugs in each panelboard as indicated on the Drawings. All lugs shall be rated for a minimum temperature of 75˚C and sized to allow termination of the quantity and size of stranded copper conductors indicated on the Drawings.

1. Main Circuit Breaker Electronic Trip Unit shall meet the following requirements:

a. Solid-state tripping system with true RMS sensing, consisting of at least three current sensors, microprocessor-based trip device and trip actuator.

b. Adjustable rotary dials for the following microprocessor-based time-current curve shaping adjustments:

1) Adjustable long-time pickup setting with a minimum of 10 setttings

2) Adjustable long-time delay – 0.5 to 24 second range

3) Adjustable short-time pickup setting – 1.5x to Max allowable by frame size

4) Adjustable short-time delay – 0.0 up to 0.5 seconds depending on frame size with selectable flat or I^2t curve shaping

5) Adjustable instantaneous setting – 2x to Max allowable by frame size

R. Circuit breakers shall be quick-make, quick-break, bolt-on type having over center toggle mechanisms with thermal magnetic trips and shall be trip free. All circuit breakers shall be by the same manufacturer as the panelboards. Multi-pole circuit breakers shall have common trips and a single operating handle. Handle tie bars will not be accepted.

S. Circuit breakers shall be provided with a means for indicating a tripped position. Circuit breaker voltage, ampere rating and number of poles shall be as indicated on the Drawings. Circuit breakers shall be equipped with individually insulated, braced, and protected connectors.

T. Circuit breakers shall have a minimum short-circuit interrupting capacity as indicated on the Drawings. The overall short circuit current rating of each panelboard shall be the value of the lowest rated circuit breaker installed within the panelboard.

U. Circuit breakers used on 480V, 3-phase, ungrounded delta power systems shall be UL listed for this service. “Slash rated” (277/480V) circuit breakers are not acceptable.

V. Circuit breakers shall include factory installed mechanical lugs that are UL listed to accept stranded copper conductors and solid copper conductors in sizes 14 AWG, 12 AWG and 10

AWG. Lugs shall be aluminum or copper. Steel or galvanized steel lugs are not acceptable. Circuit breaker lugs shall be UL listed and rated for a minimum temperature of 75°C.

W. All circuit breaker panelboards shall have a minimum of 25% "extra" space for future circuit breakers.

X. Provide spare circuit breakers as indicated on the Drawings.

Y. Single-pole circuit breakers in 120/240V, 1-phase and 208Y/120V, 3-phase panelboards having 15 or 20 ampere ratings shall be UL Listed as Switching Duty (SWD) rated.

Z. Circuit breakers protecting circuits supplying heating, ventilation or air conditioning equipment shall be UL Listed as HACR type.

AA. All wiring terminals for conductors leaving the panel shall be designed to be used with copper conductors.

BB. Bussing sequence shall be distributed phase sequence type. Bus sequence shall start at the top left phase bus of the interior for both top and bottom fed panels. Sequencing shall be A-B-C, left to right, top to bottom, front to back as viewed from the front of the panelboard.

CC. Provisions or spaces for future circuit breakers shall be located at the bottom of the panel for top feed main or at the top of the panel for bottom feed main. All open, blank circuit breaker knockouts shall be properly plugged with suitable manufacturer provided blanking devices.

DD. Locate next to each breaker, space, or provision an individual number permanently affixed to the panelboard. Numbering tape or painted numbers shall not be acceptable.

EE. Provide integral, bus mounted surge protective device (SPD) in accordance with NEC Article 242 in each new panelboard per NEC 700.8:

1. SPDs shall be UL 1449 labeled with a 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.
2. SPD applied on a 480V, 3-phase, ungrounded delta power system must be UL listed specifically for use on ungrounded power systems in accordance with NEC 242.12(2).
3. SPDs shall be UL 1449 labeled as Type 2, installed on the load side of the main service disconnect device. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. An SPD relying upon external or supplementary installed safety disconnects does not meet the intent of this specification.
4. SPDs shall be UL 1449 labeled with 20kA I-nominal (In).
5. Suppression components shall be heavy duty, thermally protected, 50kA MOVs.
6. SPDs shall provide surge current paths for all modes of protection: L-N, L-G, N-G, and L-L for grounded wye systems and L-G and L-L for ungrounded delta systems.
7. SPD shall be integral to the panelboard and shall be directly mounted to the panelboard bus bars.
8. SPDs shall meet or exceed the following criteria:

a. Surge Current Capacity Rating shall be 80kA per mode and 160kA per phase.

b. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

Nominal Voltage	L-N	L-G	N-G	L-L
120/240V, 1PH, 60 Hz	500V	600V	500V	800V
480V, 3PH, delta, 60 Hz	--	1800V	--	1800V

c. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

Nominal Voltage	L-N	L-G	N-G	L-L
120/240V, 1-phase, 60 Hz	150V	300V	150V	300V
480V, 3PH, delta, 60 Hz	--	640V	--	640V

9. SPDs shall have UL 1283 EMI/RFI filtering with active tracking up to 50dB from 10kHz to 100MHz.

10. SPDs shall be equipped with the following diagnostics:

a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED

b. Audible alarm with on/off silence function and diagnostic test function

c. Surge Counter

d. Form C dry status contact rated 150VDC or 125VAC, 1A maximum

e. No other test equipment shall be required for SPD monitoring or testing before or after installation.

11. *Environmental Conditions*:

a. Operating temperature: -4°F to 122°F

b. Relative humidity: 5 – 95%, non-condensing

12. *SPD Warranty*: SPDs shall have a full ten (10) year manufacturer's warranty from date of initial service, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

FF. The inside of the panel or door shall have a printed nameplate indicating the name of the panelboard manufacturer, the manufacturer's shop order number, panelboard type, system voltage and bus bar ampacity. Paper type labels are not acceptable. Each panelboard shall be marked with its UL short circuit current rating.

GG. All panelboards shall be built in accordance with and to meet the requirements of the applicable sections of the National Electrical Code, NEMA Publication PBl and OSHA. All panelboards shall bear the Underwriters' Laboratories (UL) label of approval.

HH. 480V, 3-phase, 3-wire ungrounded delta rated circuit breaker panelboards shall be:

1. Eaton Type PRL3X with Power Defense bolt-on branch circuit breakers

2. Square D Type I-Line Series

3. ABB-GE ReliaGear

II. 120/240V, 1-phase rated circuit breaker panelboards shall be:

1. Square D Type NQ with Type QOB bolt-on branch circuit breakers

2. Eaton Type PRL1X with Type BAB bolt-on branch circuit breakers

3. ABB ReliaGear RQ with Type THQB bolt-on branch circuit breakers

JJ. The basis of design for all panelboards is Eaton. Should the Contractor choose to provide equipment from one of the other approved manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories to make the equipment work with the existing conditions at the Facility.

KK. All panelboards and the motor control center, under Specification Section 262419 – Motor Control Centers, shall be provided from the same manufacturer.

LL. Do not order circuit breaker panelboards until the required short-circuit current ratings have been determined in accordance with Specification Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install at locations indicated on the Drawings. All mounting and supporting materials shall be provided as indicated on the Drawings and in accordance with Section 260529 - Hangers and Supports for Electrical Equipment.

B. Install panelboards in accordance with the manufacturer's written instructions.

C. Locate and arrange with proper clearances from other equipment and material to obtain good accessibility for operation and maintenance. Working space and clearances shall be in accordance with NEC Article 110.

D. Clean all scars and abrasions, remove metal splatter, rust, and all foreign materials, prep and touch-up all blemishes and scratches in the factory finish on the enclosure in strict accordance with the equipment manufacturer's instructions using primer and touch-up paint provided by the equipment manufacturer for the motor control center under Section 262419 – Motor Control Centers.

E. For panelboards ≤ 5'-8" high, install so that the top of the panelboard is 6'- 0" above the floor.

F. Panelboards furnished with external mounting tabs must be mounted to U-channel supports using the mounting tabs. Drilling mounting holes in the enclosure will void the UL listing and NEMA rating of the enclosure and will require the enclosure to be replaced.

G. Panelboards over 5'-8" high shall be mounted on a 3-1/2" high concrete housekeeping pad per Section 260500 – Common Work Results for Electrical with 1" chamfered top edge that is 2" larger than the panelboard enclosure in the front and on both sides. The panelboard shall be bolted to the floor using expansion anchor bolts meeting the requirements of Section 260529 – Hangers and Supports for Electrical Equipment with the back, near the top of the panelboard, bolted to the wall.

H. Anchor bolt size, quantity and placement shall be as indicated in the panelboard manufacturer's installation instructions for seismic certification. For floor mounted panelboards, anchor bolts shall extend through the concrete housekeeping pad into the concrete floor below the housekeeping pad. As a minimum, provide one anchor bolt at each corner with 6" minimum embedment.

I. All panelboards shall be mounted in such a way as for the center of the grip of the operating handle of the topmost circuit breaker(s) in the panelboard, when in the highest position, are not more than 6'-7" above the floor or working platform, including the height of the housekeeping pad if one is installed, for compliance with NEC 404.8(A).

J. All rigid metal conduits which terminate at panelboards shall terminate in insulated throat, grounding type, liquid tight rigid conduit hubs. Conduit hubs shall be provided in accordance with Section 260533.13 – Conduit for Electrical Systems and bonded to the panelboard equipment ground bus in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.

K. Adjust the interior such that the dead front fits securely over all the circuit breakers and there are no gaps or spaces.

L. Provide blank filler plates for all unused circuit breaker spaces in all panelboards.

M. Provide NEMA Type 12 gasketed hole seals for all unused conduit openings in panelboard enclosures.

N. *Visual and Mechanical Inspection:* Inspect all panelboards for physical damage, proper alignment, anchorage, and grounding. Check installation and tightness of connections at main lugs and at all circuit breakers in accordance with manufacturer's published torque values.

O. Perform insulation tests on each phase and verify low-resistance ground connections on equipment ground bus.

P. Reset SPD surge counter in each panelboard to zero (0) at substantial completion of the project.

3.2 IDENTIFICATION

A. Each panelboard shall have a laminated plastic nameplate on the outside surface of the door engraved with the panelboard designation as indicated on the Drawings in accordance with Section 260553 – Identification for Electrical Systems.

3.3 PANELBOARD CIRCUIT DIRECTORIES

A. Each panelboard shall have a typewritten, framed circuit directory card with a clear plastic covering mounted on the inside of the door identifying the load(s) served by each circuit breaker in accordance with Section 260553 – Identification for Electrical Systems.

3.4 ARC FLASH HAZARD WARNING LABEL

A. Provide arc flash hazard warning label on exterior door of all panelboards in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

END OF SECTION 262416

SECTION 262419 - MOTOR CONTROL CENTERS

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 SCOPE

A. The Contractor shall furnish and install a motor control center as specified herein and as shown on the Drawings.

B. This section includes mechanical, electrical and system design features that are being specified for the procurement of a safe and reliable MCC to meet the specific needs of this project.

1.3 RELATED SECTIONS

A. Section 230900 – Instrumentation and Control for HVAC

B. Section 260500 – Common Work Results for Electrical

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.13 – Conduit for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

G. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

H. Section 260583 – Wiring Connections

I. Section 262813 – Fuses

J. Section 262912 – Motor Control

1.4 SUBMITTALS

A. Manufacturer's product data sheets, descriptive bulletins and shop drawings for the motor control center shall be submitted for approval. Shop drawings shall include, but not be limited to, the following:

1. Wiring diagrams for all items, including feeder units, motor starters, electronic power and energy meter, ground detection system and surge protective device
2. Unit summaries which shall include details for starter and feeder units including disconnect type, amperage, size, control devices, and electrical devices
3. List of any deviations from contract documents and requests for clarifications of specification documents and/or drawings
4. Elevation drawings with conduit entry space availability including enclosure types and system ratings

5. Single-line diagram
6. Bill of Materials
7. Nameplate engraving schedule
8. Conduit entry/exit locations
9. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
10. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
11. Cable terminal sizes
12. Standard engineering data sheets for:
    a. Fusible disconnect switches
    b. Feeder unit circuit breakers
    c. Motor starters
    d. Solid-state overload relays
    e. Control power transformers
    f. Fuses
    g. Indicating lights
    h. Selector switches
    i. Push buttons
    j. Surge protective device (SPD)
    k. Electronic power and energy meter (EPM)
    l. Ground detection system (GDS)
13. Seismic freestanding equipment certification and equipment anchorage details as specified
14. Recommended spare parts list

B. *Record Drawings*: Manufacturer shall provide electronic copies of the following documents to Owner for review and evaluation in accordance with general requirements of Section 260500 – Common Work Results for Electrical and Division 0 and Division 1.
    1. The manufacturer shall provide a copy of the drawings that reflect the "for-installation" state of the equipment when shipped from the factory
    2. The drawings shall be in PDF format
    3. Certified Factory test reports shall be provided with "for-construction" documentation

4. A certificate of compliance for UL 845 shall be provided with “for-construction” documentation

5. A complete set of manufacturer’s descriptive literature and detailed instructions for adjusting overcurrent protective devices shall be provided for the Owner’s Representative within six (6) weeks after the protective device shop drawings have been reviewed and returned.

C. Submit Installation, Operation and Maintenance Manual in compliance with Section 017823 – Operation and Maintenance Data and Section 007213 – General Conditions. The manual shall be delivered at least two (2) weeks prior to the start-up period.

D. IO&M Manuals shall be conformed to "as-built" status by incorporating any and all changes made during the start-up period.

1.5 APPLICABLE STANDARDS

A. The equipment and components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. ANSI/NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
2. ANSI/NFPA 70, National Electrical Code
3. CSA C22.2 No. 254-05 General Requirements of Canadian Electrical Code, Part II
4. CSA C22.2 No. 14, Industrial Control Equipment
5. NEMA ICS 1, Industrial Control and Systems: General Requirements
6. NEMA ICS 2, Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
7. NEMA ICS 6, Industrial Control and Systems: Enclosures
8. NEMA ICS 18- 2001, Motor Control Centers
9. NEMA ST 20, Dry Type Transformers for General Applications
10. UL 508 Industrial Control Equipment (only for devices included in specification)
11. UL 845, Motor Control Centers
12. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
13. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
14. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
15. National Electrical Code: Article 285
16. UL 1283 – Electromagnetic Interference Filters
17. UL 1449, 4th Edition – Surge Protective Devices

1.6 QUALIFICATIONS

A. Manufacturer shall have specialized in the manufacture and assembly of low-voltage motor control centers for over thirty (30) years.

B. Low-voltage motor control centers shall be UL listed and labeled in accordance with the standards listed in Paragraph 1.5 of this Section.

C. Vertical sections and individual units shall be UL labeled.

D. SPD shall bear the UL Mark and shall be listed to the most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL listing and does not meet the intent of this specification.

E. Provide equipment that is IBC/CBC seismically qualified with seismic freestanding label.

F. Seismic compliance shall be qualified only through shake table testing. Compliance by calculations is not acceptable.

1.7 WARRANTY

A. All equipment furnished under this Section shall be guaranteed against defective parts and workmanship for a minimum of one (1) year from the date of substantial completion of the project. Any failures or deficiencies shall be corrected by the Contractor or the equipment supplier during the warranty period at no cost to the Owner.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.

B. Manufacturer shall ship no more than three motor control sections in individual shipping splits for ease of handling. Contractor shall coordinate with manufacturer the shipping splits required for the equipment and manufacturer shall show the location of shipping splits on factory drawings.

C. Each shipping split shall be mounted on shipping skids and wrapped for protection and be equipped with removable shipping angles or eyes, as determined during the shop drawing submittal review process, to aide in lifting.

D. Contractor shall inspect and report concealed damage to carrier within 48 hours regardless of the contractual shipping terms.

E. If storage is necessary, Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. It is the responsibility of the Contractor to heat enclosures to prevent condensation during storage as required to protect equipment.

F. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Lift only by installed lifting eyes or angles.

G. MCC shall never be placed on its side, back or any other position other than floor standing upright. Doing so could jeopardize the integrity of the bus and bus bracing.

1.9 EXTRA MATERIALS

A. Provide and turn over to the Owner's Representative, 10% spare fuses (minimum of 3) for each size and type of fuse used on this project, including control fuses in accordance with Section 262813 – Fuses.

B. Provide one (1) 12-ounce, minimum, aerosol can each of red-oxide or gray primer and the ANSI 49 or ANSI 61 gray topcoat paint for touching up scratches in the motor control center enclosure paint finish after installation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The motor control center shall be rated for 480-volt, 3-phase, 3-wire, 60 hertz, service that is provided from a 480V, 3-phase, 3-wire, 60 hertz, ungrounded dry-type substation transformer. The complete motor control center assembly, including all bus bracing, disconnect switches, fuse clips, circuit breakers, motor starters, surge protective device (SPD) and associated current carrying components shall be fully rated to withstand an available fault current of 42,000 RMS symmetrical amperes. Continuous current ratings shall be in accordance with temperature rise specifications set forth by UL, ANSI and NEMA Standards.

B. The motor control center shall consist of enclosed vertical sections joined together to form a rigid, free-standing assembly. The structure shall be a floor supported enclosure having a dead-front for 480-volt, 3-phase, molded case circuit breaker feeder units, fusible disconnect switches and combination motor starters, mounted in individual compartments. The construction of the motor control center shall meet the requirements set forth by Underwriters' Laboratories (UL), Publication UL-845, NEMA Publication No. ICS-2-322, and the National Electrical Code (NFPA 70). Design in accordance with IEC Standards will NOT be acceptable. All units shall be removable and shall either plug-in or bolt-on to the supply bars.

C. All auxiliary equipment, except that which is specified for mounting on the door, shall be mounted within each unit compartment. All units shall be provided with hinged unit doors, isolation barriers and unit disconnect operators as outlined in this Specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses and wireways except for openings for conductor entrance into units. Units shall be designed and constructed so that any fault will be localized within the compartment. Removable access plates shall be provided where required.

2.2 CONSTRUCTION

A. Refer to Drawings for actual layout and location of equipment and components; current ratings of devices, bus bars, and components; voltage ratings of devices, components, and assemblies; interrupting and withstand ratings of devices, buses, and components; and other required details.

B. The motor control center shall have a NEMA Type 12 gasketed enclosure, with all units being front accessible only.

C. The motor control center shall be constructed of vertical structures, each measuring 21 or 20 inches deep by 20 inches wide by 90 inches high. Conduit entry into the motor control center for incoming main conductors shall be at the bottom right-hand section of the motor control center lineup and for load conductors and control wiring shall be into the top or bottom of the motor control center. The maximum overall width of the complete motor control center assembly shall be 80-inches.

D. The vertical sections shall support the horizontal and vertical bus bars, circuit breaker feeder units, combination motor starters, fusible disconnect switches, covers and doors. Each section shall have a 7-gauge steel, 3-inch high removable lifting angle, two 1-1/2 inch high

channel sills with end covers, and shall be fabricated from structural supporting members consisting of a minimum of 13 gauge hot-rolled steel. The channel sills shall be provided with holes to permit bolting of the unit to the concrete housekeeping pad. Vertical sections shall be designed to accommodate plug-on units in front-of-board construction or bolted connection type for larger size units.

E. All starter unit disconnect switch and circuit breaker feeder unit operating handles shall be so arranged that the center of the grip of the operating handles, when in their highest position, will not be more than 6'-7" above the floor, in accordance with Article 404.8(A) of the NEC, when the MCC is installed on a 3-1/2-inch-high housekeeping pad. In other words, the center of the grip of the operating handles, when in their highest position, shall not be more than 6'-3-1/2" above the bottom of the MCC structure.

F. Horizontal wireways shall be provided in the top and bottom of each vertical section and shall be arranged to provide full length continuity throughout the entire assembly. A vertical wireway shall be provided in each section and shall extend from the top to the bottom horizontal wireways. No terminal blocks shall be located in vertical wireways. Cable tie supports shall be furnished within the vertical wireways to hold power conductors and control wiring in place. All wireways shall have screw on hinge type covers having captive type screws. All wireways shall be isolated from the bus bars.

G. Each vertical section shall be equipped with vertical side barriers to prevent faults from traveling easily between adjacent sections.

H. The motor control center shall be shipped in units consisting of no more than three (3) sections.

I. Each "shipping unit" shall be provided with adequate lifting means and shall be capable of being rolled, jacked, or lifted into installation position and bolted down to the concrete housekeeping pad.

J. The motor control assembly shall be designed to be fastened to a concrete equipment pad on a concrete floor, with the top supported to the wall and/or ceiling if recommended by the equipment manufacturer.

K. The motor control center shall be IBC/CBC Seismic Qualified. Provide a seismic freestanding label on motor control center enclosure.

L. Design Parameters:

1. Site elevation ..... 880 ft.
2. Site design air temperature range..... 40°F to 100°F
3. Location ..... Indoors

M. Design Loads:

1. The entire motor control center assembly, as well as the means of fastening to the concrete equipment pad/floor below the concrete equipment pad and the building, shall be capable of withstanding gravity, operating, and seismic loads.
2. The latest editions of the International Building Code and ASCE 7 – Minimum Design Loads for Buildings and Other Structures shall be used as the design code with the specific environmental factors as stated below.
3. Comply with the ASCE Hazards Report for site included as Attachment 1 to Section

260500 – Common Work Results for Electrical.

4. Earthquake Design Data:

a. Occupancy Classification:

1) Power Plant: Moderate-hazard factory industrial, Group F-1

2) Correctional Center: Institutional Group I-3, Condition 5

b. Risk Category: IV

c. Seismic Importance Factor: Ie = 1.5

d. Site Class: D

e. Mapped Spectral Response Accelerations: $S_s = 0.23$, $S_1 = 0.1$

f. Spectral Response Coefficients: $S_{DS} = 0.2$, $S_{D1} = 0.14$

g. Seismic Design Category: D

h. Component Amplification Factor: $A_p = 2.5$

i. Component Response Modification Factor: $R_p = 2$

j. Overstrength Factor: $\Omega_o = 2$

k. Analysis Procedure: Equivalent Lateral Force ASCE 7

N. An engraved or laser printed nameplate indicating the name of the motor control center manufacturer, the manufacturer's shop order number, the type or style, system voltage, number of phases and bus ampacity shall be mounted on the outside front surface of the motor control center.

2.3 BUS BAR CONDUCTORS

A. The main bus bars shall be horizontally mounted, having a continuous current rating of 600 amperes, and shall be continuous over the full length of the motor control center. All bussing shall be full size throughout, without reduction.

B. Incoming power to the motor control center shall be of the size, type and quantity indicated on the Drawings entering at the bottom right of the MCC and terminating on factory provided main lugs of appropriate size, type and quantity for the conductors to be terminated.

C. For distribution of power from the main horizontal bus to each vertical section a 3-phase vertical bus shall be provided in each vertical section. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

D. The vertical bus in each vertical structure shall have a continuous current rating of 600 amperes.

E. All bus bars shall be tin- or silver-plated copper and all shall be made from the same material. All plating shall be done electrolytically and shall be over the entire length of the bus. Plating must be not less than 0.003 inch thick and shall cover both sides and both edges of the bus.

F. Copper bus bar conductors (phase and ground) shall be fabricated from $1000A/in^2$ current density rated Oxygen Free High Conductivity (OFHC) Copper 102, being 99.95 per cent pure copper and having an average annealed conductivity of 101 per cent IACS. Copper bus bar conductors shall be hard-drawn temper and shall meet the requirements of ASTM Specifications B 187.

G. Copper bus connections shall be bolted. All bolted connections shall be made using hex-head bolts and Belleville washers. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus wherever a split has been made. All splice connections shall be made with at least two (2) bolts on each side of the splice.

H. All bus work and connections shall be accessible for inspection and maintenance after first removing the necessary cover plates. All current carrying bus bars shall be properly supported by insulated bus supports.

I. The main bus shall have provisions to allow for future extension. The motor control center shall be constructed to allow for the future addition of more sections on the left-hand side.

J. A horizontal tin- or silver-plated copper ground bus shall be provided in the interior throughout the full length of the motor control center. The ground bus shall have a rated ampacity equal to 50% of the main phase bus.

K. Grounding conductors shall be terminated on the ground bus using approved compression-type lugs. Provide copper compression type grounding lugs as follows:

1. Size 1/0 AWG, 1-hole, rectangular-tongue standard barrel length compression lug for the incoming main feeder equipment grounding conductor

2. Size 4/0 AWG, 2-hole, rectangular-tongue, long barrel compression lug for equipment grounding conductor to the station ground bus on north wall of the Electrical Room

L. There shall be a vertical copper ground bus in each section. The ground bus shall be accessible to a bus stab mounted in the unit compartment area and arranged so that the unit ground stab engages before the power stabs engage the vertical bus.

M. Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized busses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over". Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. The openings in the vertical bus used for starter connections shall be covered by an automatic shutter mechanism. The shutters shall automatically cover the openings when the starter is removed.

N. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure. Unused plug-on openings in the bus shall have plastic snap-in closing plates for added safety.

O. The vertical bus shall have a flame-retardant polyester-glass insulation / isolation system. This system shall insulate the vertical bus front and rear. In addition, the barrier shall isolate each phase bus. Openings in the vertical bus insulation/isolation system shall permit the entry of unit stabs. Unused openings shall have plugs or covers to prevent the entry of foreign objects.

P. The vertical bus shall be braced to the same short circuit rating as the main horizontal bus.

2.4 FEEDER AND COMBINATION MOTOR CONTROLLER UNITS

A. Feeder units shall employ molded case circuit breakers for branch circuit protection.

B. Feeder unit circuit breakers shall meet the following requirements:

1. Molded case, thermal magnetic trip type

2. UL Listed for use on 480V, 3-phase, ungrounded delta power systems. "Slash rated" (277/480V) circuit breakers are not acceptable

3. Circuit breakers shall be quick-make, quick-break, bolt-on type having over center toggle mechanisms with thermal magnetic trips and shall be trip free. All circuit breakers shall be by the same manufacturer as the motor control center. Multi-pole circuit breakers shall have common trips and a single operating handle. Handle tie bars will not be accepted

C. Combination motor controller units shall employ fusible disconnect switches.

D. All combination starter and feeder units of plug-in construction shall utilize a positive guidance system to ensure positive connection of the unit stabs to the section vertical bus. Insertion and removal of each unit shall not require the use of special tools.

E. Unit shelves shall be of a lift out design, so that the shelf may be removed without the use of special tools.

F. Connection from the power stabs to the unit disconnect shall be a direct connection.

G. Each combination starter unit size 1 through size 5 shall be of plug-in construction. Each feeder breaker rated 600A or less shall be plug-in construction.

H. Each unit compartment shall be equipped with a flange-formed pan-type door. The door shall be mounted on the vertical section with removable hinge pins.

I. Each unit shall be equipped with an operating handle that physically indicates the ON and OFF positions. The handle shall be connected to the disconnect operator using a direct drive and requiring no adjustments of linkage. On circuit breaker units the handle shall have a "tripped" position in addition to OFF/ON.

J. The handle shall be mechanically interlocked with the door preventing it from opening with disconnect closed. The interlock shall also prevent disconnect being closed with door open. The interlock shall be capable of being defeated allowing the door to be opened with disconnect closed or disconnect closed with the door open to allow maintenance by a trained person with the correct PPE and proper authorization from management to perform work on energized equipment.

K. The unit handle shall have provision to padlock in the ON or OFF position with up to three padlocks having heavy duty industrial type shackles.

L. Each unit shall be capable of being padlocked in a partially withdrawn position. In this position, the unit power stabs are disengaged from the vertical bus and no power can enter the unit.

2.5 COMBINATION MOTOR CONTROLLER DISCONNECT SWITCHES

A. All disconnect switches shall be quick-make, quick-break, fusible, dual horsepower and continuous current rated for the indicated motor controller size, dead front, externally

operated, front accessible, having visible blades.

B. The disconnect switches shall have fuse clips that only accept UL Class J fuses.

2.6 MAGNETIC MOTOR CONTROLLERS

A. The NEMA size of each motor controller shall be as indicated on the Drawings.

B. All motor controllers and motor control components shall be NEMA design and horsepower rated. IEC design will NOT be acceptable.

C. All three-phase motor controllers shall be the combination type consisting of a fusible disconnect switch and an electrically held, 480-volt AC magnetic contactor, vertical action solenoid type. Contactor and switch shall be dual horsepower and continuous current rated for the indicated NEMA starter size. Each motor controller shall be mounted along with the associated fusible disconnect switch in an individual compartment equipped with a hinged door.

D. Unless otherwise indicated, all magnetic motor controllers shall be full voltage (across-the-line), single-speed, non-reversing type.

E. Combination motor controller units specified with Type B or C wiring shall be supplied with split-type control terminal blocks. The terminal blocks shall be front mounted and shall allow the removal of the unit without disconnecting any of the control wiring. Combination starter units up to size 5 shall be plug-in construction and shall be capable of being removed without disconnecting any control leads from their terminal blocks.

F. Combination type motor controllers shall safely interrupt 42,000 amperes of fault current.

G. All contactor coils shall be rated for 120 volts, 60 hertz.

H. Each motor controller shall be provided with a minimum of one normally open and one normally closed auxiliary "spare" contacts. Additional auxiliary contacts shall be provided as indicated on the Drawings or as necessary for meeting the control circuit requirements.

2.7 MOTOR OVERLOAD PROTECTION

A. Each motor starter contactor shall include a three-pole overload relay with an external manually operated reset mechanism mounted on the starter door.

B. Overload relays in combination motor controller units shall be solid-state, ambient insensitive, self-powered, including adjustable FLA, phase unbalance, phase loss protection, selectable overload class (10, 20), with 2% accuracy and repeatability, built-in thermal memory to prevent hot motor starts and 1 NO and 1 NC isolated auxiliary contacts.

C. Solid state overload relays shall be Eaton Model 440, Square D MotorLogic Class 9065 or approved equal by Allen-Bradley or ABB.

2.8 MOTOR CONTROLLER PROTECTION

A. Motor controllers shall be protected from short circuits by UL Class J, dual element, time delay, current limiting fuses to provide Type 2 protection. This level of protection shall allow no damage to the controller, under low- and high-level fault conditions up to 42,000 amperes.

2.9 CONTROL POWER

A. All control power shall be 120 volts, 60 hertz.

B. Each motor controller unit shall contain a 480V/120V control voltage transformer of adequate size to obtain 120-volt control power, unless otherwise indicated.

C. The control power transformer shall be provided with one secondary line fused and the other secondary line grounded. A properly sized fuse shall be provided in each 480-volt primary conductor to the control power transformer. Control power transformer shall be oversized by a minimum of 50 volt-amperes, unless otherwise indicated.

2.10 CONTROL DEVICES

A. Push buttons, selector switches and pilot lights shall be provided in each starter door as indicated on the Drawings.

B. Each starter shall have a red "RUN" pilot light and a green "OFF" pilot light mounted on the exterior side of the starter door. Pilot lights shall be wired through starter contactor auxiliary contacts. Do not parallel the "RUN" pilot light across the contactor coil.

C. Pilot light units shall be NEMA Type 4/13 (watertight/oiltight), 30 or 30.5 mm round metal, panel mounted, 120 volts AC, push-to-test, full-voltage type using LED Type lamps. Lamps shall be replaceable by removal of the color cap. Color of pilot lights shall be as indicated on the Drawings and as required by these Specifications.

D. Push button units and selector switches shall be NEMA Type 4/13 (watertight/oiltight), 30 or 30.5 mm round metal, panel mounted. "START" push button units shall have a fully guarded or flush green button. "STOP" push button units shall have an unguarded or extended red button. Selector switches shall have the Standard Operator, unless otherwise indicated.

E. Each pilot light, push button, or selector switch shall be identified with the device manufacturer's engraved collar legend nameplate having the wording as shown on the Drawings.

F. Any additional control relays, timing relays, and other devices, as indicated on the Drawings, shall be provided inside the starter enclosure.

G. The auxiliary contact on the local motor disconnect safety switch specified in Section 262816.16 – Enclosed Switches shall be wired by the Contractor to the combination starter unit in the MCC to break the control power circuit when the local motor disconnect safety switch is open.

H. The control wiring schematic shall be as shown on the Drawings, with all wires numbered as indicated.

2.11 SURGE PROTECTIVE DEVICE (SPD)

A. SPD shall be UL 1449 labeled with a 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

B. SPD must be UL listed specifically for use on a 480V, 3-phase, ungrounded delta power system in accordance with NEC 242.12(2).

C. SPD shall be UL 1449 labeled as Type 2, installed on the load side of the main service disconnect device. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. An SPD relying upon external or supplementary installed safety disconnects does not meet the intent of this specification.

D. SPD shall be UL 1449 labeled with 20kA I-nominal (In).

E. Suppression components shall be heavy duty, thermally protected, 50kA MOVs.

F. SPD shall provide surge current paths for all modes of protection: L-G and L-L for 3-phase, ungrounded delta systems.

G. SPD unit shall be integral to the motor control center and shall be connected to the MCC bus bars by means of a molded case thermal magnetic circuit breaker.

H. SPD shall meet or exceed the following criteria:

1. Surge Current Capacity Rating shall be 120kA per mode and 240kA per phase

2. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

Nominal Voltage	L-G	L-L
480V, 3PH, delta, 60Hz	1800V	1800V

3. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

Nominal Voltage	L-G	L-L
480V, 3PH, delta, 60Hz	640V	640V

I. SPD shall have UL 1283 EMI/RFI filtering with active tracking up to 50dB from 10kHz to 100MHz.

J. SPD shall be equipped with the following diagnostics:

1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED

2. Audible alarm with on/off silence function and diagnostic test function

3. Surge Counter

4. Form C dry status contact rated 150VDC or 125VAC, 1A maximum

5. No other test equipment shall be required for SPD monitoring or testing before or after installation.

K. *Environmental Conditions*:

1. Operating temperature: -4°F to 122°F

2. Relative humidity: 5 – 95%, non-condensing

L. *Warranty*: SPD shall have a full ten (10) year manufacturer's warranty from date of initial service, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

2.12 ELECTRONIC POWER AND ENERGY METER

A. Provide a microprocessor based electronic power and energy meter (EPM) in motor control center connected to the main bus as indicated on the Drawings, to measure as a minimum:

1. Instrumentation
    a. Current, per phase and neutral, total
    b. Current, demand
    c. Voltage, per phase (L-L, L-N), total
    d. Minimum/maximum readings; I, V
    e. Minimum/maximum readings; I, V, PF, F, W, VAR, VA
    f. Frequency
2. Power
    a. Real, reactive and apparent power (W, VAR, VA)
    b. Power factor, per phase, total
    c. Real, reactive and apparent power demand
3. Demand methods
    a. Block interval (sliding, fixed)
4. Energy
    a. Real, reactive and apparent energy, total (Wh, VARh, VAh)
5. Statistics
    a. MAX with time stamp and MIN with time stamp
        1) Each phase of V and I
        2) Total of W, VAR, VA, PF and Hz
        3) Demand of I1, I2, I3, W, VAR and VA
6. Communications
    a. RS-485, Modbus RTU/ASCII, KYZ output
    b. DNP3.0
7. Realtime clock
    a. Year, month, date, hour, minute, second
8. Ethernet
    a. Modbus TCP/IP (RJ45) or BACnet/IP (to be selected as part of shop drawing submittal process)
9. Revenue accuracy
    a. ANSI C12.20 (0.5 or 0.2%)
10. Environmental
    a. Operating temperature: -13°F to +158°F
    b. Storage temperature: -40°F to +185°F
    c. Relative humidity: 5% to 95%, noncondensing
    d. Protection level: IP54 (front), IP30 (cover)

B. EPM shall have 4” minimum LCD backlit display and "soft" keys for function selection.

C. Provide control power transformer with input disconnect switch and primary and secondary fusing for 120VAC input power to the EPM.

D. Provide 5A window type current transformers with shorting-type terminal blocks for the EPM current inputs.

E. Provide three (3) 480VAC to 120VAC potential transformers for voltage inputs to the EPM. Motor control center bus voltage shall not be connected directly to the meter.

F. Instrument transformers shall comply with NEMA Standard EI 21.1, "Instrument Transformers for Revenue Metering 110 kV BIL and Less”, IEEE Standard C57.13, "Requirements for Instrument Transformers."

2.13 GROUND DETECTION SYSTEM (GDS)

A. Provide a ground detection system to indicate when any of the three phases of the 480V, 3-phase, 3-wire, ungrounded delta power system has become grounded.

B. The ground detection system shall meet the following requirements:

1. Install in a 6” high dedicated control bucket in the motor control center that is located at a convenient viewing/operating height (between 52” and 66” above the bottom of the MCC as indicate in the MCC1 elevation view on the Project Drawings).

2. Provide three (3) white LED pilot lights, one for each phase, and a black, momentary push button in the door of the control compartment and terminal blocks, fuses and resistors, of the appropriate rating, inside the control compartment wired as required to function as follows:

a. In normal conditions, all indicator lights shall be illuminated dimly.

b. When a solid ground fault occurs on one phase, the indicator light on that phase will not be illuminated and the indicator lights on the other two phases will illuminate brighter to indicate that there is a ground fault on the phase with the light that is not illuminated.

c. *Lamp Test Function*: Pressing the test push button, will remove the ground connections to the indicator light neutrals causing all three (3) indictor lights to illuminate as in the normal operating condition unless one or more of the indicator lights is burned out.

2.14 WIRING

A. The motor control center wiring shall be NEMA Class I, Type B. All internal control wiring of a compartment shall be brought to a terminal mounted in the compartment for easy extension of wiring to externally located components. All internal interconnecting wiring of control circuits within the motor control center shall be done by the manufacturer, as shown on the Drawings. All wiring going to remote items shall leave the motor control center via terminal blocks which shall be accessible from the front.

B. *Power Wiring*: Furnish and install the required wiring to connect units to power buses and terminal blocks.

1. Wiring shall be minimum 12 AWG, 65-strand, copper with black, 90°C,

thermoplastic insulation.

C. *Control Wiring*: Furnish and install the required wiring to connect units as indicated on the typical control schematics shown on the Drawings.

1. Wiring shall be minimum 14 AWG, 41-strand copper with red, 105°C, thermoplastic insulation.

2. Neutral lead for control power transformer source shall be white in color.

3. Neutral grounding wire for control power transformer source shall be green in color and connected to the motor control center ground bus.

4. Terminate all wiring at terminal block points where indicated for remote control and status.

5. Terminate all wiring with insulated, spade-tongue type, compression terminals.

D. Terminal Blocks:

1. Heavy-duty, 600 volt, 20-amp minimum, pull-apart design.

2. Binding screw type terminal suitable for insulated, spade-tongue type, compression terminal.

3. All wiring terminals for conductors leaving the motor control center shall be designed to be used with copper conductors.

4. Permanently marked terminal block points.

5. Provide a minimum of five (5) spare grouped terminal points for each combination motor starter unit.

E. Each compartment shall have an internal connection wiring diagram mounted on the inside of the door.

2.15 SPARE AND SPACE COMPARTMENTS

A. Where a compartment is shown as a "SPARE", it shall contain a complete fusible disconnect switch unit or combination starter unit, whichever is indicated on the Drawings, less fuses and thermal overload elements.

B. Where a compartment is shown as a "SPACE" on the Drawings, it shall have a blank door or cover and be fully equipped and ready to receive a plug-in combination motor starter or fusible disconnect switch of the size and type noted. Space for future switches or motor starters shall be bussed for the maximum devices that can be fitted into them.

2.16 SPARE FUSES

A. The Contractor shall provide three (3) spare fuses for each size and type used in the motor control center, including control circuit fuses, in accordance with Section 262813 - Fuses.

2.17 NAMEPLATES

A. Each cubicle door, disconnect switch, motor starter and all instruments and control devices shall have engraved laminated plastic nameplates in accordance with Section 260553 – Identification for Electrical Systems.

B. Mounted on the exterior surface of each compartment door shall be a laminated plastic

nameplate having 3/8-inch high engraved black characters on a white background.

C. The nameplate identifying the motor control center as "MCC1" shall have 1/2-inch high engraved black characters on a white background.

D. Nameplates shall be engraved as shown on the Drawings or as indicated in these Specifications.

2.18 FINISH

A. All surfaces of the motor control center shall be properly cleaned and prepared for painting and shall have, as a minimum, a baked on finish consisting of one coat of rust-inhibiting primer and a finish coat, having a minimum dry film thickness of 2.5 mils, of ANSI-61 light gray or ANSI-49 gray paint, exterior and ANSI-70 white, interior.

B. All interior and exterior surfaces as well as bolted joints shall have a complete finish coat on and between them.

C. Unpainted steel parts shall be zinc plated.

2.19 APPROVED MANUFACTURERS

A. Eaton Freedom 2100 equipment has been used as the basis of design for this project. Equipment from one of the other approved manufacturers will be acceptable subject to Designer's confirmation of equivalency through the shop drawing submittal review process. Any modifications to the building or existing conduits/wiring required by use of an alternate supplier's equipment shall be the responsibility of the Contractor at no additional cost to the Owner.

B. Approved manufactures:

1. ABB-GE ReliaGear
2. Eaton Freedom 2100
3. Square D by Schneider Electric Model 6

C. The motor control center and all panelboards, under Specification Section 262416 – Panelboards, shall be provided from the same manufacturer.

D. NOTE: Do not order the motor control center until the required short-circuit current ratings have been determined in accordance with Section 260573 – Overcurrent Protective Device Coordination Study and Arc Flash Risk Assessment.

2.20 FACTORY TESTING

A. The motor control center shall be tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.

B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.

C. Electrical tests before shipment shall include:

1. Power circuit phasing
2. Control circuit wiring

3. Control power transformers

4. Device electrical operation

5. AC Dielectric tests (per NEMA ICS 1-109-21) of:

   a. Power circuits

   b. Control circuits

D. The manufacturer shall provide certified copies of factory test reports as part of the Installation, Operation and Maintenance Manual required in Paragraph 1.4 C of this Section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The following procedures shall be performed by the Contractor prior to the start of installation:

1. Verify UL labeling of the assembly.

2. Verify installation area will provide working space and clearances required by NEC Article 110-26.

3. Check concrete pads for uniformity and level surface.

4. Verify that equipment is ready to install.

5. Verify field measurements are as shown on Drawings.

6. Verify that required utilities are available, in proper location and ready for use.

7. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. The Contractor shall follow the installation instructions supplied by the manufacturer.

B. Rig the MCC assembly into final location and install on a new 3-1/2-inch high concrete housekeeping pad per Section 260500 – Common Work Results for Electrical with 1" chamfered top edge that is 2" larger than the MCC enclosure all around. Center of housekeeping pad shall be open to allow full access for routing conductors into the bottom of the MCC from the existing cable trench that is located under the MCC. Bolt MCC to floor using expansion anchor bolts meeting the requirements of Section 260529 – Hangers and Supports for Electrical Equipment. Anchor bolt size, quantity and placement shall be as indicated in the equipment manufacturer's installation instructions for seismic freestanding certification. Anchor bolts shall extend through the concrete housekeeping pad to provide the required embedment in the concrete floor below the housekeeping pad. Support the top of the MCC to the wall and/or ceiling if recommended by the equipment manufacturer.

C. All metallic conduits shall be terminated at the motor control center using liquid tight, insulated throat, grounding type threaded conduit hubs in accordance with Section 260533.13 – Conduit for Electrical Systems and shall be bonded to the MCC equipment ground bus in accordance with the requirements of Section 260526 – Grounding and Bonding for Electrical Systems.

D. The MCC equipment ground bus shall be bonded to the motor control center structure and shall be properly connected by the Contractor to the nearest approved grounding point with a conductor as indicated on the Drawings.

E. Control wiring shall be as shown on the Drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

F. Check all removable cells and starter units for easy removal and insertion.

G. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.

H. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.

I. Torque all bolted connections made in the field in accordance with manufacturer's published values and verify all factory bolted connections.

J. Provide NEMA Type 12 gasketed hole seals for all unused conduit openings.

K. Clean all scars and abrasions, remove metal splatter, rust, and all foreign materials, prep and touch-up all blemishes and scratches in the factory finish on the enclosure in strict accordance with the equipment manufacturer's instructions using primer and touch-up paint provided by the equipment manufacturer.

L. Perform insulation tests on each phase and verify low-resistance ground connections on equipment ground bus.

M. Install required safety labels on the outside of the enclosure.

N. Reset SPD surge counter in the motor control center to zero (0) at substantial completion of the project.

3.3 ARC FLASH HAZARD WARNING LABELS

A. Provide an arc flash hazard warning label on the front exterior of each vertical structure of the motor control center in accordance with Sections 260553 – Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment prior to turning operation of the equipment over to the Owner.

3.4 MOTOR OVERLOAD RELAY SETTINGS

A. The Contractor shall adjust the overload relay trip setting for each motor in accordance with NEC Article 430 requirements. All motor nameplates shall be checked for the full load current rating and allowable temperature rise to determine the correct overload relay setting for the corresponding starter.

B. It shall be the Contractor's responsibility to ensure that the motor starter overload relay is properly set for each motor to suit the particular application and environment of the motor and respective starter. To this extent, the Contractor shall consult with the manufacturer of the motor and the equipment being driven by the motor, to ensure that the overload relay is set properly.

C. The Contractor shall "seal" all overload relay adjustments to prevent unauthorized personnel from changing settings using Square D "TUSEAL," or approved equal, trip unit seals.

3.5 CLEANING

A. Remove all construction debris from inside base of equipment enclosure, all wiring compartments and all individual feeder and motor controller units.

B. Clean dirt from exterior of enclosure and touch up blemishes in the finish using paint furnished by the manufacturer.

END OF SECTION 262419

SECTION 262813 – FUSES

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 SCOPE

A. The Contractor shall furnish and install all fuses as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

C. Section 262419 – Motor Control Centers

D. Section 262816.16 – Enclosed Switches

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Each type of fuse

1.5 EXTRA MATERIALS

A. The Contractor shall provide and turn over to the Owner’s Representative, 10% spare fuses (minimum of 3) for each size and type of fuse used on this project, including control fuses.

PART 2 - PRODUCTS

2.1 250-VOLT AND 600-VOLT FUSES

A. Fuses and their applications shall meet all the requirements of NEMA, the National Electrical Code (NFPA 70) and OSHA Part 1910 Subpart S. Fuse sizes and types shall be as shown on the Drawings and in schedules. Fuses shall be properly coordinated and shall be verified by the Contractor for the final load served. All fuses shall be Underwriters' Laboratories (UL) approved and shall have standard NEC dimensions.

B. Fuses used on circuits up to 250 volts shall be dual element, time delay, current limiting and shall have a minimum short circuit interrupting capacity of 300,000 RMS symmetrical amperes, UL Class RK1, LPN-RK, 250V for sizes up to 600 amperes.

C. Fuses used on circuits above 250 volts up to 600 volts shall be 600V, dual element, time delay, current limiting and shall be one of the following:

1. UL Class J, having a minimum short circuit interrupting capacity of 300,000 RMS symmetrical amperes, for sizes up to 600 amperes.

2. UL Class CC, having a minimum short circuit interrupting capacity of 200,000 RMS symmetrical amperes, for sizes up to 30 amperes. Class CC fuses are only to be used were specifically indicated on the Project Drawings.

D. Motor controllers shall be protected from short circuits by UL Class J dual element, time delay, current limiting fuses to provide UL Type 2 protection. This level of protection shall allow no damage to the controller, under low- and high-level fault conditions.

E. Control circuit fuses (less than 5 amps) and associated fuse holders shall be as shown on the Drawings.

F. Fuses shall be as manufactured by the Cooper Bussmann Manufacturing Division of Eaton or approved equal by Mersen or Littlefuse.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall not be shipped and/or delivered to the job site with the fuses installed in place.

B. Install fuses in fuse clips with fuse label, indicating fuse type, voltage and ampere rating, facing out such that the information is visible for inspection without removing the fuse from the fuse clips.

END OF SECTION 262813

SECTION 262816.16 – ENCLOSED SWITCHES

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 SCOPE

A. The Contractor shall furnish and install all disconnect safety switches as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260526 – Grounding and Bonding for Electrical Systems

C. Section 260529 – Hangers and Supports for Electrical Equipment

D. Section 260553 – Identification for Electrical Systems

E. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment

F. Section 260583 – Wiring Connections

G. Section 262813 – Fuses

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for each type and size of disconnect safety switch used.

B. Provide dimensioned outline drawing for each size and type of enclosed switch.

PART 2 - PRODUCTS

2.1 DISCONNECT SAFETY SWITCHES

A. Each disconnect safety switch shall be 600VAC, heavy duty type, single-throw, fusible or non-fusible type as indicated on the Drawings, dual horsepower rated, dead front and front accessible, having a non-teasible positive quick-make, quick-break contact mechanism rated for the voltages indicated on the Drawings.

B. Fusible type disconnect switches shall be designed to allow insertion of UL Class J fuses only. Fuse sizes shall be as indicated on the Drawings.

C. All fusible disconnect switches, size 200 amps and below, shall be equipped with non-metallic fuse pullers.

D. The switch operating handle shall physically indicate the ON and OFF positions of the switch. The switch operating handle shall be able to accept a minimum of two padlocks

for padlocking the handle in the OFF position and shall have the capability of accepting at least one padlock for padlocking the handle in the ON position. Padlocking provisions for the handle shall be based on using padlocks having heavy duty industrial type shackles 3/8-inch thick. The switch operating handle shall be an integral part of the switching mechanism, providing permanent control of the contacts, and shall be attached to the box or enclosure base and not to the cover or door.

E. The cover or door shall be mechanically interlocked with the switch operating handle to prevent opening the cover or door when the switch is in the ON position. An interlock override device shall be provided to allow authorized personnel to release the interlock for inspection purposes when the switch is in the ON position.

F. All switch blades shall be fully visible in the OFF position with the enclosure door open.

G. The switch voltage and ampere rating and the number of poles for each disconnect switch shall be as indicated on the Drawings.

H. Terminal lugs shall be Underwriters' Laboratories (UL) listed as being suitable for copper conductors and shall be equipped with solderless connectors, front removable. All current carrying parts shall be plated by electrolytic processes to resist corrosion and to promote cool operation.

I. Heavy duty switches shall have permanently attached arc suppressors, hinged or otherwise, attached to permit easy access to line-side lugs without removal of the arc suppressors.

J. Switches used in circuits having a neutral conductor shall be provided with an insulated groundable solid neutral terminal bar.

K. Each disconnect safety switch shall be equipped with a copper grounding bar or lugs that is/are bonded to the switch enclosure for termination of all equipment grounding conductors entering or leaving enclosure.

L. An electrical interlock for wiring into the control circuit shall be provided on each disconnect safety switch. The interlock shall have one or two normally open and one or two normally closed sets of contacts, as indicated on the Drawings, which shall be mechanically operated from the switch mechanism, breaking the control circuit before the main switch blades break (open) and making the control circuit before the main switch contacts make (close). The contacts shall be rated 120 volts AC/DC, 15 amperes continuous, 60 hertz.

M. Switch enclosures shall be NEMA Type 12 without knockouts for indoor areas and NEMA Type 3R without knockouts for outdoor locations.

N. All enclosures shall be prime coated with a rust-inhibiting phosphate and finished in ANSI-61 light gray or ANSI-49 gray baked-on enamel paint.

O. All enclosures shall meet UL Standard 98, shall be UL listed and labeled, and shall meet the applicable requirements of Federal Specifications WS-865c and NEMA Specifications KS1-1983.

P. Enclosed switch approved manufacturers are:

1. Eaton Type DH Series

2. ABB Type TH Series

3. Square D Type H Series

Q. Do not order enclosed switches until the required short-circuit current ratings have been determined in accordance with Specification Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide disconnect switches, where required by NFPA 70, where indicated on Drawings, and where required by equipment manufacturer, in a location convenient for maintenance on each switch and adjacent equipment.

B. Provide fused disconnect switches, where required by NFPA 70, where indicated on the Drawings or when required to maintain equipment manufacturer's warranty or UL listing, in a location convenient for maintenance on each switch and adjacent equipment.

C. Provide UL Class J fuses in accordance with Section 262813 – Fuses having the ampere rating indicated on the Drawings in fusible type disconnect switches.

D. Mount all enclosed switches on U-channel supports in accordance with Section 260529 – Hangers and Supports for Electrical Equipment on the equipment frame or adjacent to the equipment served by the switch.

E. Install fuses in fuse clips with fuse label, indicating fuse type, voltage and ampere rating, facing out.

3.2 IDENTIFICATION

A. Mounted on the outside surface of each disconnect safety switch door shall be a three-layer engraved laminated plastic nameplate meeting the requirements of Section 260553 – Identification for Electrical Systems.

B. Provide durable fuse identification label permanently attached to the inside of the door of each fusible disconnect switch indicating fuse type, size and device(s) controlled.

END OF SECTION 262816.16

SECTION 262912 – MOTOR CONTROL

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 SCOPE

A. The Contractor shall furnish and install all motor controls as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cable

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260529 – Hangers and Supports for Electrical Equipment

E. Section 260533.13 – Conduit for Electrical Systems

F. Section 260553 – Identification for Electrical Systems

G. Section 262419 – Motor Control Centers

1.4 DEFINITIONS

A. Where the term “motor starter” is used on the Drawings or in these specifications it shall be understood to have the same meaning as the term “motor controller” and the term “full-voltage across-the-line motor starter” shall have the same meaning as the term “across-the-line motor controller” as indicated herein.

1.5 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Control stations
2. Each type of control device
3. Solid state overload relays
4. Manual single-phase motor starters

PART 2 - PRODUCTS

2.1 GENERAL

A. All control voltages shall be 120 volts AC, 60 hertz, unless otherwise indicated.

B. All motor control components shall be NEMA design and horsepower rated. IEC design will NOT be acceptable.

2.2 CONTROL STATIONS

A. Control stations shall be NEMA Type 4 (watertight). Control stations shall include push button units, selector switch units, pilot light units and/or other units as shown on the Drawings. Manufacturer's legend plates shall be installed as identified on the Drawings. Miniature type control devices shall not be used, unless otherwise indicated.

B. Each control station shall have an interconnection point-to-point wiring diagram mounted inside the enclosure.

C. Approved control station manufacturers shall be:

1. Allen-Bradley
2. Eaton
3. ABB
4. Square D Company

2.3 PILOT LIGHTS

A. Pilot light units shall be NEMA Type 4/13 (watertight/oiltight), 30 or 30.5 mm round metal, panel mounted, 120 volts AC, push-to-test, full voltage type using high-intensity LED type lamps. Lamps shall be replaceable by removal of the color cap. Color of pilot lights shall be as indicated on the Drawings and as required by these Specifications.

B. "RUN" or “ON” functions shall use green pilot light and "OFF" function shall use red pilot light. Pilot light color to be used for other functions shall be as indicated on the Drawings.

C. Provide the device manufacturer’s standard engraved collar legend nameplate to identify the function of each pilot light as indicated on the Drawings.

D. Pilot lights shall be Allen-Bradley 800T or approved equal by Eaton, ABB or Square D.

2.4 PUSH BUTTONS

A. Push button units shall be NEMA Type 4/13 (watertight/oiltight), 30 or 30.5 mm round metal, panel mounted. "START" push button units shall have a fully guarded or flush black button. "STOP" push button units shall have an unguarded or extended red button.

B. Provide the device manufacturer’s standard engraved collar legend nameplate to identify the function of each push button as indicated on the Drawings.

C. Push buttons shall be Allen-Bradley 800T or approved equal by Eaton, ABB or Square D.

2.5 SELECTOR SWITCHES

A. Selector switches shall be NEMA Type 4/13 (watertight/oiltight), 30 or 30.5 mm round metal, three-position, maintained contact, panel mounted with the Standard Operator, unless otherwise indicated.

B. Provide the device manufacturer's standard engraved collar legend nameplate to identify the function of each selector switch as indicated on the Drawings.

C. Selector switches shall be Allen-Bradley 800T or approved equal by Eaton, ABB or Square D.

2.6 SOLID STATE OVERLOAD RELAYS

A. Provide three-pole overload relay with an external manually operated reset mechanism mounted on the starter door.

B. Overload relays shall be NEMA rated, self-powered, ambient temperature compensated or ambient temperature insensitive, solid state type with field selectable Class 10 or Class 20 trip with 2% accuracy and repeatability, built-in thermal memory to prevent hot motor starts and shall include adjustable FLA, phase unbalance and phase loss protection and 1 NO and 1 NC isolated auxiliary contacts.

C. Overload trip current range shall be field adjustable and adjustment range should be such that the FLA of the motor to be protected falls near the mid-point of the adjustment range.

D. Solid state overload relays shall be Eaton Model 440, Square D MotorLogic Class 9065 or approved equal by Allen-Bradley or ABB.

2.7 MOTOR CONTROLLER PROTECTION

A. Motor controllers shall be protected from short circuits by UL Class J, dual element, time delay, current limiting fuses to provide Type 2 protection. This level of protection shall allow no damage to the controller, under low- and high-level fault conditions up to 42,000 amperes.

2.8 MANUAL SINGLE-PHASE MOTOR STARTERS

A. Starters for 115-volt single-phase motors shall be manual type, full voltage, two-pole, maintained contact, rated one horsepower, 115/230 volts, single phase, 60 hertz, NEMA 4 or 12 enclosure, surface mounted as indicated on the Drawings.

B. Starter shall be provided with a thermal overload in each phase conductor.

C. Starter overloads shall actuate a trip-free mechanism which shall open the starter contacts even if the switch handle is held in the ON position. A reset device shall be provided on the front of the starter enabling the trip mechanism to be reset after the overloads have cooled.

D. Switch shall be toggle type, pad-lockable, and shall indicate the ON and OFF positions

E. Starters shall be provided with a red neon or LED pilot light mounted in the cover and connected to the load side of the thermal overload unit elements.

F. Starters with pilot light shall be Square D Catalog No. 2510FW2P or approved equal by Eaton, ABB, or Allen-Bradley.

PART 3 - EXECUTION

3.1 GENERAL

A. Equipment shall be wired as shown on the Drawings and/or in accordance with approved coordinated wiring diagrams to provide the intended function.

B. Motor starters and controls shall be rigidly secured and installed plumb and level. Connecting conduits shall not be used to support starters or control enclosures unless specifically shown on the Drawings.

C. Manually operated devices, such as push buttons, selector switches, and manual starters, shall be located to permit convenient operation.

D. The Contractor shall receive, unload, handle and set all separately mounted motors and all other electrical equipment shown on the Drawings or described in the Specifications.

E. All motors, whether they are separately mounted or attached to other equipment, shall be promptly and properly lubricated by the Contractor.

F. The Contractor shall furnish and install all conduit and wiring as indicated on the Drawings, from motor disconnect switch to motor terminal box, and all control wiring, making all required connections.

G. The Contractor shall carefully check the Specifications and Drawings to verify the equipment to be furnished and the location and control points for all motors and shall install all wiring required or furnished for the project.

H. The Contractor shall momentarily energize the motor after the final connections have been made, to ensure that correct rotation has been obtained.

I. Motor starters, contactors and relays shall be adjusted to operate smoothly without chatter and excessive hum.

J. Motor horsepower and related starter sizes, wiring and conduit sizes, as well as system interconnecting control wiring as shown on the Drawings, are based on the best available information. The Contractor shall be responsible for furnishing and installing, at no additional cost to the Owner, the proper size motor starters, conduit, and wire based upon the actual motor horsepowers which will be used rather than those shown on the Drawings, to make all equipment and motors as actually furnished completely operable in accordance with the Specifications.

K. Any increase in motor horsepowers resulting in the need for larger motor starters, larger wire and conduit sizes, etc., because of an increase in motor horsepowers due to the Contractor's final design of the particular system, shall be provided by the Contractor at no additional cost to the Owner.

3.2 IDENTIFICATION

A. Provide a laminated plastic nameplate, in accordance with Section 260553 – Identification for Electrical Systems, mounted on the exterior surface of each control station, manual motor starter and motor terminal connection box.

3.3 MOTOR OVERLOAD PROTECTION

A. The Contractor shall adjust the overload relay trip setting for each motor in accordance with the National Electrical Code. All motor nameplates shall be checked for the full load current rating and allowable temperature rise to determine the correct overload relay setting for the corresponding starter.

B. It shall be the Contractor's responsibility to ensure that the motor starter overload relay is properly set for each motor to suit the particular application and environment of the motor and respective starter. To this extent, the Contractor shall consult with the manufacturer of the motor and the equipment being driven by the motor, to ensure that the overload relay is set properly.

C. The Contractor shall "seal" all overload relay adjustments to prevent unauthorized personnel from changing settings using Square D "TUSEAL" trip unit seals, or approved equal by ABB-GE, Allen-Bradley or Eaton.

END OF SECTION 262912

SECTION 263213.16 – DIESEL-ENGINE-DRIVEN GENERATOR SET CONTROLS

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 SCOPE

A. The Contractor shall furnish upgrade an existing diesel engine-generator set with electro-mechanical control system, with the necessary microprocessor based electronic controls, including all appurtenances, as specified herein and as shown on the Drawings, to provide 10-second automatic start and operation of the generator to provide emergency power for the Moberly Correctional Center in Moberly, Missouri.

1.3 RELATED SECTIONS

A. Section 230900 – Instrumentation and Control for HVAC

B. Section 231330 – Fuel Oil Day Tank – Diesel Engine Driven Generator

C. Section 233313.13 – Volume-Control Dampers

D. Section 233423 – HVAC Power Ventilators

E. Section 235750 – Remote Radiator – Diesel Engine Driven Generator

F. Section 260500 – Common Work Results for Electrical

G. Section 260526 – Grounding and Bonding for Electrical Systems

H. Section 260529 – Hangers and Supports for Electrical Equipment

I. Section 260553 – Identification for Electrical Systems

J. Section 261350 – Neutral Grounding Resistor

K. Section 263290 – Medium-Voltage Generator Connection Cabinet

L. Section 263623 - Medium-Voltage Automatic Transfer Switch

1.4 SECTION INCLUDES

A. The work covered under this section shall include, but not be limited to, the following items:

1. Generator control panel
2. Remote annunciator panel
3. Three (3) “ship loose” remote emergency stop push button and enclosure assemblies

4. Computer interface module to allow control and monitoring of engine-generator set from Owner's existing Schneider Electric StruxureWare building automation system

5. Diesel fuel for startup and operation of engine-generator set prior to substantial completion of the project

6. Temporary diesel-engine-driven generator and 480V-4.16Y/2.4kV, 3-phase step-up transformer, if the provided generator is 480Y/277V, 3-Phase in lieu of 4.16Y/2.4kV, 3-phase to provide standby emergency power for the facility at all times when the existing emergency system is out of service.

7. On site startup and load testing of the engine-generator control system

8. On site Owner training on the engine-generator control system

9. Air permit determination

10. Fuel spill prevention, control and countermeasures plan

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with the requirements of Section 260500 – Common Work Results for Electrical.

B. Shop drawings shall be submitted for approval prior to release of the equipment for manufacturing and shall include, but not be limited to, the following:

1. Factory published specification sheet indicating standard and optional accessories, ratings, for the control equipment.

2. Breakdown of all components and options to be included

3. Product data showing interconnection points and internal wiring diagrams for generator control panel, battery charger, day tank, remote radiator fan motor starter, generator room ventilation equipment and remote annunciator

4. Control panel and remote annunciator dimensioned outline drawings (plans and elevations) showing overall measurements, mounting provisions, and interconnect points for electrical connections.

5. Interconnecting wiring diagrams and schematics for complete emergency system, including generator, medium-voltage automatic transfer switch, day tank, battery charger, medium-voltage generator connection cabinet, fuel system, cooling system and remote alarm indications and remote computer interface. These drawings shall be specific to the project requirements and provided by Fabick Power Systems in conjunction with Caterpillar. Factory drawings that provide multiple interconnections for items not specific to the project will be rejected.

6. Control panel schematics

7. Field wiring diagrams indicating all necessary wiring to from remote systems and devices to the new generator control panel.

8. Manufacturer's and dealer's written warranty disclosure statement for the period specified.

9. Location and description of supplier's parts and service facility within a three (3) hour drive time of the jobsite, including parts inventory, number of qualified technicians and service vehicles, normal and emergency telephone numbers and contact person.

C. Fabick Power Systems shall provide copies of field technician's factory training certificates specific to the proposed generator set controls upgrade in order to verify the level of support capabilities. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Major engine and control parts shall be available within 24 hours from the time a component is deemed defective.

D. Submit startup and commissioning test reports including full-load resistive load bank test report.

E. Installation, Operation & Maintenance Manuals: Provide IO&M Manuals that describe installation, operation, and maintenance of the equipment in compliance with Section 017823 – Operation and Maintenance Data and Section 007213 – General Conditions and Section 260500 – Common Work Results for Electrical.

F. O & M Manuals shall be provided as follows:

1. Submit three (3) sets of manuals bound in 8-1/2 inch by 11-inch (A4) text pages, except drawings reduced to 11-inch by 17-inch pages may be folded for inclusion in the manuals. The manuals shall be provided in electronic (.pdf) format. Upload the PDF file to the Missouri OA FMDC project management website, Trimble (fka eBuilder).
2. Each hard copy of the manuals shall be assembled and bound into hard-back, post-type binders suitable for rough usage. Three-ring, snap-ring type binders are not acceptable.
3. Prepare binder cover and spline inserts with printed title, “OPERATION AND MAINTENANCE INSTRUCTIONS FOR PACKAGED ENGINE-GENERATOR CONTROL SYSTEM”, title of project, project number, and subject matter of binder when multiple binders are required.
4. Internally subdivide binder contents with permanent page dividers, logically organized as described below, with tab titling clearly printed under reinforced, laminated, plastic tabs.
5. Operation and maintenance manuals shall include:
    a. Table of contents
    b. Appropriate design criteria
    c. List of equipment
    d. Parts list for each component
    e. Operating instructions
    f. Maintenance instructions for equipment and systems
    g. Shop drawings and product data
    h. Photocopies of warranties
    i. Test reports
    j. Manufacturer’s detailed instructions for start-up, shutdown, operation and maintenance, including drawings, wiring diagrams and schematics for the engine, generator, remote radiator and day tank
    k. Bill of materials and manuals/data sheets for individual components
    l. Manufacturer’s recommended spare parts list

m. Manufacturer's recommended preventive maintenance schedule

n. Oil sampling and analysis for engine wear

o. Emergency maintenance procedures

G. Manuals shall be conformed to "as-built" status by incorporating any and all changes made during the start-up period.

1.6 REFERENCES

A. The equipment covered by this section of the Specifications shall be designed, assembled and tested in accordance with the latest applicable ANSI, NEMA, UL, NFPA and EPA Standards, including, but not limited to:

1. ANSI/NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
2. ANSI/NEMA MG 1 Motors and Generators
3. ANSI/NFPA 70 National Electrical Code
4. ANSI/NEMA AB 1 Molded Case Circuit Breakers
5. NFPA 30 – Flammable and Combustible Liquid Code
6. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines
7. NFPA 110 – Emergency and Standby Power Systems
8. UL 142 – Steel Above Ground Tanks for Combustible Liquids
9. UL 2200 – Stationary Engine Generator Assemblies
10. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver to project site and store and protect products at the project site in accordance with the provisions of Section 260500 – Common Work Results for Electrical.

B. Accept all equipment on site and document any and all damage upon receipt at the project site.

1.8 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the requirements of Section 260500 – Common Work Results for Electrical.

B. Accurately update all control submittal items to reflect the "as-built" conditions and issue a "FOR RECORD" revision to all applicable documents.

1.9 QUALIFICATIONS

A. *Manufacturer*: Caterpillar (manufacturer of existing CAT 3516 diesel-engine-driven generator that is being upgraded with new electronic controls).

B. *Supplier*: Fabick Power Systems division of Fabick CAT, who provided field service for modifications to the engine on the existing CAT 3516 diesel-engine-generator to re-rate it

from 1300kW continuous duty to 1450kW standby duty in September 2020, shall be the sole-source provider for all work specified in this Section. Contact information:

1. Chris Zahari, Account Manager
   Fabick Power Systems
   101 Fabick Dr.
   Fenton, MO 63026
   314-412-0003
   christopher.zahari@fabick.com

2. Mark Schellert, Product Support Representative
   Fabick Power Systems
   101 Fabick Dr.
   Fenton, MO 63026
   314-791-3915
   mark.schellert@fabick.com

1.10 WARRANTY

A. The standby engine-generator control system be warranted by the manufacturer against defective materials and factory workmanship for a period of 2 years after the date of substantial completion. Any and all defective parts shall be repaired or replaced at the manufacturer's option, free of charge including travel and labor during the term of the warranty.

B. The Owner shall be allowed to perform his own preventive maintenance on the unit during the warranty period without voiding the warranty. The Owner will keep a log of all maintenance on the unit to certify compliance with the engine-generator manufacturer's requirements as published in the O&M Manuals.

C. Satisfactory warranty documents must be provided. Authorized distributor shall provide copies of factory authorization warranty repair certificates specific to the proposed product on electrical systems control repair in order to verify the level of support capabilities. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

PART 2 - PRODUCTS

2.1 GENERAL

A. The existing packaged diesel-engine-driven generator set is a Caterpillar 3516, 4,160Y/2,400 V, 3-phase, 4-wire, 60 Hz, 1,4500 kW standby duty unit that was installed in 1986 inside the Power Plant at the Moberly Correctional Center in Moberly, Missouri. The engine is liquid cooled with an outdoor, remote radiator that is mounted on grade just outside the generator room. The fuel injectors were replaced on the engine and the engine was retuned by a Caterpillar factory authorized service technician from the Fabick Power Systems division of Fabick CAT, Fenton, Missouri in September 2020 under a contract with CK Power Systems, St. Louis, Missouri to re-rate the generator set from an output of 1,300 kW continuous to 1,450 kW standby.

B. After the modifications to the engine to re-rate the unit from continuous to standby duty a full load test using a resistive load bank was conducted but was aborted prematurely due to the unit beginning to show signs of overheating. The engine cooling and generator room ventilation systems are to be replaced under this project, see Division 23 specifications, to allow the unit to produce full rated output power.

C. The CK Power Systems inspection report and close-out report, after all contracted work was completed, are included in Attachment 1 to this specification section for reference.

D. All new equipment and materials shall be new, and where applicable, shall bear the Underwriters' Laboratories, Inc. (U.L.) Label of Approval. The electric generator shall be UL Listed and Labeled.

E. Furnish a complete and coordinated control system which provides all necessary interfaces between the diesel engine-generator, and the generator auxiliaries. All necessary switches, starters, contactors, and overloads required for the generator auxiliaries shall be furnished.

F. The diesel engine-generator set control system shall meet the following requirements:

1. The rated output voltage of 4,160 volts (line-to-line) shall have a manual adjustment of ±5%.
2. Voltage regulation shall not exceed ±0.5%.
3. Voltage steady-load bandwidth shall not exceed ±1%.
4. The voltage transient performance:
    a. Dip, with step application of 25% load, shall not exceed 5%.
    b. Rise, with step removal of 25% load, shall not exceed 5%.
    c. Recovery time shall not exceed 1.5 seconds.
5. The frequency shall be manually adjustable from 56 to 64 Hz.
6. The frequency steady-load operational bandwidth shall not exceed ±0.5% of rated frequency from no load to full load.
7. The frequency transient performance:
    a. Dip, with step application of 25% load, shall not exceed 3.6 Hz.
    b. Rise, with step removal of 25% load, shall not exceed 3.6 Hz.
    c. Recovery time shall not exceed 2 seconds.

G. The diesel engine-generator control system shall consist of the following major components:

1. Existing Caterpillar 3516 diesel-engine-driven generator
2. New Caterpillar ECS100 generator controller
3. Control interfaces to new remote radiator with fan under Section 235750 – Remote Radiator-Diesel Engine Driven Generator
4. Existing 24VDC batteries and battery charger
5. Control interfaces to new fuel oil day tank under Section 231330 – Fuel Oil Day Tank-Diesel Engine Drive Generator

6. Control interfaces to new fuel transfer (between new day tank and existing diesel-engine-driven generator) system

7. Control interfaces to new generator room ventilation system under Section 233313.13 – Volume-Control Dampers and Section 233423 – HVAC Power Ventilators

8. Control interfaces to the new medium-voltage automatic transfer switch under Section 263623 – Medium-Voltage Automatic Transfer Switches.

9. Control interfaces to the new medium-voltage generator connection cabinet under Section 263290 – Medium-Voltage Generator Connection Cabinet.

10. Control interfaces to the existing building automation system (BAS) under Section 230900 – Instrumentation and Control for HVAC

11. Control interface to new emergency generator remote radiator cooling water flow transmitter

12. New remote annunciator

13. New remote computer interface

14. New remote emergency stop push buttons and enclosures

H. Fabick Power Systems and Caterpillar shall design the controls for the entire emergency system, which shall encompass the existing diesel-electric generator set and the new generator control panel.

I. Fabick Power Systems shall assume full responsibility for the coordination of all control wiring design between the components of the emergency system, and shall provide whatever interface components and contacts necessary to achieve this.

J. Fabick Power Systems shall provide field technicians and supervision as required to ensure successful implementation of the generator control system retrofit.

2.2 THEORY OF OPERATION

A. The automatic transferring of the Moberly Correctional Center loads from the normal power source to the emergency generator power source shall be accomplished by means of a new medium-voltage closed-transition automatic transfer switch unit specified under Section 263623 – Medium-Voltage Automatic Transfer Switch (MVATS).

B. The mode of operation shall be determined by the position of the Engine Control Switch (ECS) located on the Generator Control Panel. The ECS shall be a three-position selector switch having maintained contacts. The three (3) positions shall be (1) AUTOMATIC, (2) MANUAL, and (3) OFF.

C. The following shall be the sequence of events when the Engine Control Switch is in the AUTOMATIC position:

1. When any phase of the normal power source fails or drops below 70% of the rated voltage, the automatic transfer time delay “on” starting relay (“on delay” set for 3 seconds) located inside each of the source-transfer switchgear units shall be energized. When the time delay relay times out, the relay contact shall close, starting the emergency generator. When the generator reaches rated voltage and frequency, the medium voltage source-transfer switches shall automatically

transfer the load from the normal (utility) source to the emergency generator (emergency) source.

2. Upon restoration of normal power (when the normal voltage is greater than 90% of rated voltage in all three phases), the source-transfer switchgear units shall, after a time delay (set for 10 minutes), automatically retransfer the load back to normal power source. Then after an additional time delay (normally about 5 to 10 minutes) shall shut down the engine-generator set. Drop out and pick up voltages shall be factory calibrated.

D. The following shall be the sequence of events when the Engine Control Switch is in the MANUAL position:

1. The engine-generator set will automatically start immediately and come up to rated voltage and frequency. The engine-generator set shall then be manually controlled and shall continue to operate until the Engine Control Switch is turned to OFF.

E. The OFF position of the Engine Control Switch shall shut down the engine-generator set at the end of the cool-down time period.

F. The Generator Control Panel shall include a red mushroom head EMERGENCY STOP push button that, when depressed, shall do the following:

1. Trip the emergency source (generator) circuit breaker in the MVATS and shut down the engine-generator set immediately without a cool-down time period.

2.3 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with all requirements specified herein, provide products by Caterpillar and Fabick Power Systems as indicated under Article 1,9 – Qualifications herein.

2.4 GENERATOR CONTROL PANEL

A. A local Generator Control Panel shall be provided for complete control and monitoring of the existing CAT 3516 engine-generator set. The control panel shall be housed in a NEMA Type 12, surface mounted, dead front, 14-gauge (minimum) steel enclosure mounted on a floor mounted U-channel support rack next to the engine-generator set. Critical components shall be environmentally sealed to protect against failure from moisture and dirt.

B. The Generator Control Panel shall include, but shall not be limited to, the following items/features:

1. Automatic start/stop operation of engine-generator set by means of a complete 2-wire automatic engine start-stop control which starts the engine on closing contacts and stops the engine on opening of the contacts.

2. Cyclic cranking limiter with crank and rest cycles, individually adjustable shall be provided to open the staring circuit after eight attempts if the engine has not started within that time.

3. Adjustable cooldown timer

4. Emergency Stop push button

5. Three (3) position AUTO / MANUAL / OFF Engine Control Switch (ECS)

6. True RMS sensing digital AC metering (0.5% true RMS accuracy) with phase selector switch
    a. Generator output alternating current (AC) voltage (L-L)
    b. Generator output alternating current (AC) voltage (L-N)
    c. Generator output alternating current (AC) amperes
    d. Generator frequency, accuracy ±0.195 hertz
    e. Generator output kilowatts (kW) – Total and per phase
    f. Generator output kilovolt-amperes (kVA) – Total and per phase
    g. Generator output kilovolt-amperes-reactive (kVAR) – Total and per phase
    h. Generator output power factor – Overall and per phase
    i. Generator output percentage of rated power output
    j. Generator output kilowatt-hours (kWhr)
    k. Generator output kilovolt-ampere-hours (kVAhr)
    l. Generator output kilovolt-ampere-reactive-hours (kVARhr)
7. Digital engine monitoring
    a. Lubrication oil pressure
    b. Coolant temperature
    c. Revolutions-per-minute (RPM)
    d. Running time (hours)
    e. Engine successful start counter
    f. Engine crank attempt counter
    g. Service maintenance interval
    h. Fuel consumption (gal/hr)
    i. Total fuel consumed (gal)
    j. Air filter differential pressure
    k. Boost pressure
    l. Engine crankcase pressure
    m. Engine exhaust temperature (left and right)
    n. Engine intake manifold temperature
    o. Engine oil temperature
    p. Fuel filter differential pressure
    q. Fuel pressure
    r. Oil filter differential pressure
    s. Oil temperature
8. Digital display of system direct current (DC) voltage
9. Generator voltage adjustment potentiometer for the voltage regulator

10. Governor isochronous speed control
11. Frequency control
12. Engine run (ER) relay with 120 VAC, 10-amp Form "C" contacts that change state when the engine is running
13. Engine run auxiliary relay with three (3) sets of 120 VAC, 10-amp, Form "C" contacts brought out to terminal strips. The relay shall operate on generator start and run.
14. Common fault relay with 120VAC, 10-amp Form “C” dry contacts that change state for a generator fault condition shall be provided for customer use.
15. 120VAC, 10-amp dry contact for interlocking with the building intake and exhaust louver actuators such that the contact opens upon generator start command to cause the louvers to open.
16. Sensors and individual LED pilot lights and 24 VDC alarm horn to annunciate both visually and audibly the following:
    a. Generator run status
    b. Lubrication Oil Low Pressure Alarm
    c. Lubrication Oil Low Pressure Shutdown
    d. Lubrication Oil High Temperature Alarm
    e. Engine Low Temperature Alarm
    f. Engine High Temperature Alarm
    g. Engine High Temperature Shutdown
    h. Engine Overcrank Shutdown
    i. Engine Overspeed Shutdown
    j. Control Switch Not In Auto
    k. Battery Charger Failure Alarm
    l. Low DC Voltage Alarm
    m. High DC Voltage Alarm
    n. Low Coolant Level Alarm
    o. Generator Breaker Open
    p. Emergency Stop Activated
    q. Over Voltage Alarm
    r. Under Voltage Alarm
    s. Over Frequency Alarm
    t. Under Frequency Alarm
    u. Overcurrent Alarm
    v. Reverse Power Alarm
    w. Low Fuel Pressure Alarm
    x. Low Fuel Pressure Shutdown

y. High Fuel Pressure Alarm

z. High Fuel Pressure Shutdown

aa. Fuel Filter Restriction Alarm

bb. Fuel Filter Restriction Shutdown

cc. High Intake Manifold Air Temperature Alarm

dd. High Intake Manifold Air Temperature Shutdown

ee. Low Fuel Supply Alarm

ff. Fuel Tank Leak Alarm

gg. Fuel Tank High Level Alarm

17. Audible alarm, 24 volts DC, flush mounted, 101 dB(A) at 10 feet; Edwards Type 871-G1, or approved equal

18. Alarm Acknowledge/Horn Silence push button

19. LAMP TEST push button for testing lamps in all of the pilot and annunciator lights on the control panel door, as well as the audible alarm

20. Main thermal-magnetic circuit breaker to disconnect all power within the control panel

21. Automatic voltage regulator specified elsewhere in this Section

22. Isochronous electronic governor speed control specified elsewhere in this Section

C. An overspeed device shall be provided for the unit separate from the governor to automatically stop the engine should the speed exceed 115-120% of rated speed. The overspeed trip shall be immediate in action and shall be of a type which must be reset by hand. An emergency shutdown device shall be incorporated with the overspeed trip. The generator main circuit breaker shall trip "open" when this device is activated.

D. All adjustments used for regulating the voltage, speed, fuel, cooling water, lubricating oil pressure and such parts shall be shock mounted.

E. The control panel shall incorporate self-diagnostics capabilities and fault logging.

F. The control panel shall have digital LCD indication and LED indicating lights, for alarms and pre-alarms. The control panel shall have "key-pad" programmability and shall have a backup means for the program, EPROM or long life lithium battery, such that the system memory and program data is not lost in the event of a control power (engine starting battery) failure.

G. Control panel shall be suitable for operation in a 20°F to 120°F, 0 to 100% relative humidity environment.

H. The emergency generator control panel shall include an interface which communicates with the Owner’s Building Automation System (BAS) using either a Modbus TCP/IP or Modbus RTU protocol.

I. Fabick Power Systems shall coordinate with the Owner’s BAS integrator, which shall be C&C Group (Corey Schepers, 919-530-7369, cschepers@c-cgroup.com).

J. Fabick Power Systems shall provide the necessary information to C&C Group to provide proper integration of emergency system controls and alarms into the existing Schneider Electric StruxureWare BAS.

2.5 REMOTE ANNUNCIATOR

A. Provide a Remote Engine Annunciator Panel in compliance with NFPA 110 for a Level 1 system with LED indicating lights and 24 VDC alarm horn. Include the listed pre-alarm and alarm points, audible alarm, alarm silencing means, repetitive alarm circuitry, and lamp test switch in a flush mounted panel with brushed stainless-steel finish. Provide all interconnecting wiring in conduit per manufacturer's requirements by the Electrical Contractor. The remotely reported alarms shall include the following:

1. Generator Running
2. Emergency Power Supply (EPS) Supplying Load
3. Emergency Stop / Emergency Power Off (EPO) Switch Activated
4. Generator Breaker Open
5. Control Switch Not In Auto
6. Lubrication Oil Low Pressure Alarm
7. Lubrication Oil Low Pressure Shutdown
8. Engine High Temperature Alarm
9. Engine High Temperature Shutdown
10. Engine Low Temperature Alarm
11. Low Coolant Level Alarm
12. Engine Overcrank Shutdown
13. Engine Overspeed Shutdown
14. Battery Charger Failure Alarm (includes AC failure)
15. High Battery Voltage Alarm
16. Low Battery Voltage Alarm
17. Low Fuel Main Tank Alarm
18. Low Fuel Day Tank Alarm
19. High Fuel Day Tank Alarm
20. Fuel Oil Tank Leak Alarm
21. Day Tank Pumps Running Status
22. Day Tank Control System Fault Alarm

B. Audible alarm shall be 24 volts DC, flush mounted, 101 dB(A) at 10 feet; Edwards Type 871-G1 or approved equal.

C. Provide Alarm Acknowledge/Horn Silence push button.

D. Provide Lamp Test push button for testing all indicator lights on the remote annunciator.

E. The remote annunciator shall interface to the General Control Panel specified elsewhere in this Section. Any required relay contacts to activate the alarms on the remote annunciator shall be provided.

F. The remote annunciator modules shall be environmentally sealed and housed in a NEMA 1 or NEMA 12 enclosure for surface mounting.

G. All inputs and outputs shall be protected against short circuits to (+/-) battery and shall have reverse polarity protection.

H. The remote annunciator shall be suitable for operation in a 20°F to 120°F, 0 to 100% relative humidity environment.

2.6 ACCESSORIES

A. Remote Manual Stop Stations (Emergency Power Off – EPO): Provide three (3) red, mushroom head, maintained contact type emergency power off (EPO) push buttons in a NEMA Type 12 or 13 stainless steel or painted, cast aluminum control enclosure for emergency shutdown of the generator.

1. Two (2) mounted in generator room adjacent to each of the two (2) egress doors as indicated on the Drawings

2. One (1) mounted remotely next to the generator annunciator in the Power Plant office as indicated on the Drawings

3. Push buttons shall be of the same type and design as the EPO push button mounted in the new Generator Control Panel.

B. The new generator control panel shall provide automatic monitoring of the EPO switches. All generator EPOs shall be field wired to the Generator Control Panel such that activation of any of the EPO push buttons shall shut down the engine-generator immediately without a cool-down time period, trip the emergency source (generator) circuit breaker located in the new MVATS open, and initiate a visual and audible alarm at each generator annunciator panel and the remote generator annunciator panel.

C. Provide an engraved laminated plastic nameplate on all generator EPO push button enclosures with 1/4-inch high engraved white characters on a red background with the following wording:

GENERATOR
E-STOP

2.7 FACTORY TESTS

A. The generator control panel manufacturer shall perform all standard tests as required by UL, after the fabrication is complete and the panel shall have a UL label applied prior to shipment from the factory.

2.8 EXTRA MATERIALS

A. Provide five (5) spare indicator lamps of each size and type used I the control panel (if applicable)

B. Provide three (3) spare control fuses of each size and type used in the control panel.

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 and referenced standards.

B. Install “shipped loose” items in accordance with the engine-generator manufacturer’s written instructions and as indicated on the Drawings.

C. Provide conduit and wiring/cabling in accordance with the engine-generator manufacturer’s written instructions and as indicated on the Drawings to connect the various components of the emergency power system together to make a complete and functioning system.

D. Install remote EPO stations in locations shown on the Drawings. Provide 24V DC power wiring and communications cable in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams.

3.3 START-UP SERVICES

A. Field inspection and testing will be performed under provisions of Section 260500 – Common Work Results for Electrical and in compliance with NFPA 37 and NFPA 110 requirements.

B. Fabick Power Systems shall include the services of factory authorized field technician(s) for the following:

1. Verify that all equipment is installed properly
2. Check all auxiliary devices for proper operation including battery charger, jacket water heater(s), generator anti-condensation heater, generator control panel, remote annunciator, remote computer interface, remote radiator fan, day tank, generator room ventilation system, etc.
3. Test all alarms and safety shutdown devices for proper operation and annunciation
4. Check all fluid levels
5. Start engine and check for exhaust, oil and fuel leaks, vibrations, etc.
6. Verify proper voltage and phase rotation at each medium voltage source-transfer pad-mounted switchgear unit before connecting to the load

C. Prior to any testing, and before starting the diesel engine, the Fabick Power Systems factory authorized service representative shall perform the following:

1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations under the environmental conditions present and expected.

2. Accessories that normally function while the set is in standby shall be checked prior to cranking the engine. This shall include, but not be limited to, engine jacket water heater(s), battery charger, and generator anti-condensation heater.

3. Tests shall be made to check for exhaust leaks, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage, and phase rotation.

4. Prior to the electrical loading of the generator set, the controls shall be tested for normal operation.

D. Provide portable test resistive load bank for full load test. Provide 4.16kV-480V, 3-phase step-down transformer if a 480V 3-phase load bank is to be used. Simulate power failure including operation of source-transfer switchgear, automatic starting cycle, and automatic shutdown, and return to normal.

E. The Contractor shall fill the fuel oil day tank to 100% capacity and shall measure and record the fuel level in both above ground fuel oil storage tanks in the presence of the Owner’s Representative prior to the start of the test.

F. The Designer and the Owner shall be notified two (2) weeks in advance of the time and date of this test.

G. The on-site installation test shall be conducted as follows after all work, including controls upgrades, remote radiator replacement, indoor fuel oil day tank replacement, generator room ventilation system upgrade and all electrical system upgrades have been completed and accepted:

1. With the prime mover in a “cold start” condition and the building load at standard operating level, a primary power failure shall be initiated by opening the service entrance main fusible load-interrupter switch supplying the Ameren utility power to the facility.

2. The test load shall be the 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 voltage, frequency, and amperes shall be recorded.

8. The prime mover oil pressure and water temperature shall be recorded, where applicable.

9. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.

10. When primary power is returned to the buildings, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.

11. The time delay on the prime mover cool down period and shutdown shall be recorded.

12. Allow prime mover to cool for 5 minutes.

13. A resistive load shall be applied for a 4-hour, full load test. The facility 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.

    a. The new medium-voltage generator connection cabinet shall be used as the connection point for resistive load bank.

    b. Contractor shall provide a 4.16kV to 480V step down transformer if a 480-volt load bank is utilized.

    c. 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.

14. 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. Remote radiator cooling water flow

    g. Room temperature (interior)

    h. Oil pressure

    i. Engine exhaust temperature

    j. Engine inlet temperature

    k. Oil Temperature

    l. Battery charge rate

15. 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.

16. Test alarm and shutdown circuits as typically performed by the generator supplier.

17. The load test with building load, or other loads that simulate the intended load, shall be continued for 2 hours, observing and recording load changes and the resultant effect on voltage and frequency.

18. Correct of all malfunctions such as the elimination of all oil and water leaks, miss-wiring and improper control functions found during testing.

H. The Contractor/Fabick Power Systems shall provide all necessary metering and measurement equipment required for all testing.

I. After the test run is concluded and systems have been demonstrated to be satisfactory and ready for permanent operation, all lubrication checked and replenished, if required. Temporary piping, ducting, wiring, instrument connections, etc., shall be removed, and openings restored in a permanent manner acceptable to the Owner's Representative.

J. Upon completion of the test, the Contractor shall fill the fuel oil day tank to 100% capacity and shall add the required amount of fuel to both above ground fuel oil storage tanks to return the fuel level in each tank to its level prior to the start of testing.

K. Submit test report(s) with test results and indicating time and date of testing and names of individuals present during testing to the Owner for record.

3.4 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.5 CLEANING

A. Clean work under provisions of Division 00 and Section 260500 – Common Work Results for Electrical.

B. Clean engine and generator surfaces.

3.6 DEMONSTRATION

A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner’s Representative and the Designer.

B. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency standby power.

3.7 TRAINING

A. Provide on-site Owner training by a factory trained field service technician to instruct the Owner's personnel in the proper operation and routine maintenance of the generator control equipment. Review operation and maintenance manuals, parts manuals and emergency service procedures. This shall be done in accordance with the requirements of Section 017900 – Demonstration and Training after completion of the acceptance testing.

B. The training sessions shall be video recorded by the Contractor/Fabick Power Systems in accordance with Section 017900 – Demonstration and Training, and the video file uploaded to the Missouri OA FMDC project management website, Trimble (fka eBuilder).

3.8 AIR PERMIT DETERMINATION

A. The Moberly Correctional Center (MCC) does not presently have an air permit determination for the existing CAT 3516 diesel-engine-driven generator located at the

MCC Power House that includes all other combustion engine driven generators at the MCC.

B. Engage an environmental engineering company to provide an air permit determination for the existing CAT 3516 diesel-engine-driven generator after the new controls modifications specified herein have been completed.

C. Obtain all required information from project documents, Owner information and a site visit to observe the as-installed condition.

D. Provide a draft copy of the determination letter for review and a final, "For Record", air permit determination.

E. Approved Environmental Engineering Companies:

1. Geotechnology, LLC
2. SCI Engineering
3. UES Professional Solutions, LLC

3.9 FUEL SPILL PREVENTION, CONTROL AND COUNTERMEASURES (SPCC) PLAN

A. The Moberly Correctional Facility (MCC) does not presently have a fuel spill prevention, control and countermeasures (SPCC) plan for the MCC facility.

B. Engage an environmental engineering company to provide a SPCC Plan for this facility that includes the new fuel oil day tank specified in Section 231330 – Fuel Oil Day Tank – Diesel Engine Driven Generator as well as all existing fuel storage tanks at the Moberly Correctional Center.

C. Obtain all required information from project documents, Owner information and site visit to observe the as-installed condition.

D. Provide a draft copy of the SPCC plan for review and a final, For Record, SPCC document to be signed by an authorized person at the MCC and kept on file at the MCC.

E. The environmental engineering company engaged to provide the SPCC Plan shall be the same company that is engaged to provide the air permit determination under Article 3.8 above.

END OF SECTION 263213.16

SECTION 263213.16 – DIESEL-ENGINE-DRIVEN GENERATOR SET CONTROLS

ATTACHMENT 1 – Existing Diesel-Engine-Driven Generator - 2020 Maintenance and Re-Rating Work

Generator System Inspection Report

Inspection Codes

X	OK
R	Repairs/ Adjustment Made
F	Follow Up Required
N/A	Not Applicable

Customer	Moberly Correctional Center	Date	7/7/2020
Customer No.	C05025	Engine Hours	1038.2
Unit No. or Location	5201 S Morley ST. Moberly, Mo.65270	Technician	Adam Raycraft
Engine Model	Caterpillar 3516D	Generator Model	684FDR8449GG W
Engine Serial No.	25Z00654	Generator Serial No.	RK-19-51670-9/6
W/O or Job #	SVO097589	Generator Spec No.	

Electrical System			
Check Battery Electrolyte Level and Top Off			X
Check and Record Battery Voltage Reading	27.2	VDC	X
Clean Battery Posts & Terminals & Apply Corrosion Inhibitor			X
Clean Exterior of Battery Cases			X
Tighten Battery Connection Terminals (if/as required)			X
Record Battery P/N, Replacement Date and Qty	8/3/2017-qt 4 8D (1500cca)		X
Check Battery Charger Operation and Record Charge Rate	3	Amps	X
Lubrication System			
Check Engine Oil Level and Add Oil (if/as required)			X
Take Engine Oil Sample and Have Lab Analysis Performed	Oil sample taken		X
Visually Inspect Oil for Contamination			X
Check Engine for Oil Leaks			X
Check for Excessive Crankcase Blowby w/ Engine Running			X
Cooling System			
Check Coolant Level and Correct Level (if/as required)			X
Check Coolant Condition and Note Type of Coolant			X
Check for Coolant Leaks			X
Check Coolant Hose Condition			X
Take Coolant Sample and Have Lab Analysis Performed	SAMPLE TAKEN		X
Check Coolant Conditioner Level /Coolant Sample			N/A
Check Antifreeze Protection Level	-30	Degrees	F
Check Condition of Belts/Record Belt P/N (if possible)	Sureset B112	Part Number	X/F
Re-tension Belts			X
Check Jacket Water Heater Operation	Left Bank inopertable		F
Heater Shut off Valves Installed (Y or N)			X
Inspect Radiator Core			X
Test Radiator Cap & Record Size	10	PSI/Size-replace due to age	F
Fuel System			
Check & Record Fuel Level in Main Storage Tanks	9,000 gallons per tank		X
Check & Record Fuel Level in Day Tank	100%		X
Drain Water and Sediment from Main and Day Tanks	South storage tank removed 300 gallons of water, North tank was dry, day tank was dry		X
Check Fuel Day Tank Operation			X
Check Fuel Pressure	70 psi		X
Check for Fuel Leaks			X
Drain Water from Fuel and Water Separators	dry		X
Check Governor Operation			X

Check and Lubricate Governor Linkages		X
Take Fuel Sample(s) and Have Lab Analysis Performed	SAMPLE TAKEN	X
Clean Primary Fuel Filer (if screen type)		N/A

Air Induction and Exhaust System

Record Part Number of Air Filter Elements	QT-2 8N-6309 Part Number	F
Inspect Air Intake Piping, Connections and Intake Manifold		X
Inspect Operation of Air Intake Louvers, Damprs & Actuators		X
Inspect Turbocharger Compressor Wheel (if accessible)		X
Check Turbocharger Shaft End Play (if accessible)		X
Inspect Exhaust System for Leaks		X
Check Condition of Silencer		X

Generator & Voltage Regulator

Remove Cover and Inspect Generator Components		X
Check Generator Condensation Heater (if applicable)		N/A
Inspect Couplings and Guards		X
Inspect Bearing and Bracket, and Lubricate		X
Inspect/Tighten Terminal Strip Connections		X
Inspect Contactors, Relays & Timers	Start relay and PCB board has issues, part is obsolete, unit fails to start every time, suggest controls upgrade due to obsolete parts	F
Megger test generator insulation	EPS PERFROMED, WILL HAE REPORT, PASSED	X

Engine / Generator Protection Devices

Check Engine Over Crank Alarm		X
Check Engine Over Speed Shutdown		X
Check Engine Low Oil Pressure Shutdown		X
Check Engine High Coolant Temperature Shutdown		X
Check Control Panel Gauges and Warning Lights		X
Check Remote Annunciator Panel Operation		X

Engine Mounts

Inspect for Proper Installation and Loose Fasteners		X
Inspect Vibration Isolators for Proper Adjustment		X

System Operational Checks

Check Cooling System for Coolant Leaks		X
Check Engine for Oil and Fuel Leaks		X
Check/Record Battery Charging Alternator Output	27.1 VDC/Amps 2	X
Check for Unusual Noises or Vibrations		X
Record Engine Oil Pressure	68 PSI	X
Record Engine Coolant Temperature	170 Degrees	X
Record Engine RPM	1800 RPM	X
Record Generator Frequency	60 Hz	X

Record Generator Voltage	Phase1	4160	Phase2	4160	Phase3	4160

Post Run Checks

Check Engine Oil Level	X
Check Cooling System Fluid Level	X
Return System to Auto Mode	N/A
Return Area to Condition it was in upon Arrival	X
Record Part Number or Attach Photos of any Component Noted as Defective	X

Comments / Recommendations

Generator main controller will not always command unit to start when placed in run Position on panel. After diagnosing we changed 2 relays around to get unit to start Tried several more times, relay did not fix the issue, appears to be in the PCB board

That is no longer available. Tired to research replacement part, not available. Controls are age of unit and suggest full upgrade. Generator breaker does not display Last inspection or testing, breaker is 40+ years old and suggest it to be tested for Proper operations or upgraded and replaced. Block heaters need replacement thermostats.

Air filters should be replaced due to age. Batteries suggest replaced due to age Fuel sample only taken from day tank. Radiator cap suggest replace due to age Placed die in fuel system to check for internal fuel leaks, found that every cylinder Injector was leaking after the system was pressurized causing fuel dilution, suggest Injector replacement in all cylinders.

CK Power
Chris Holtgreven

FAX:
PHONE:
SAMPLE TYPE: **OIL**
SAMPLE SHIP TIME (days): 3

COMPANY NAME: CK Power
CUSTOMER EQUIP NUM: 25Z00054
COMPARTMENT NAME: ENGINE
SERIAL NUMBER: 25Z00054
MANUFACTURER: CATERPILLAR
MODEL: 3516
JOB SITE:
EXT WARR NUMBER:

SHOP JOB NUM:
COMP SERIAL NUM:
COMPARTMENT MODEL:
COMP MANUFACTURER:
SAMPLE LABEL NUM:
FLUID BRAND/WEIGHT: MFA/15W-40
FLUID TYPE:
EXT WARR EXPIRE DATE:
FUEL CONSUMED:

FABICK CAT
Missouri - 636-680-1500
Wisconsin - 920-498-8000
www.fabickcat.com

LAB CONTROL NUMBER	SAMPLE DATE	PROCESS DATE	EQUIPMENT METER	METER ON FLUID	FLUID CHANGED	MAKE UP FLUID	MAKE UP FLUID UNITS	FILTER CHANGED
D12M-50191-0002	06-Jul-2020	09-Jul-2020	1038.2 HR	1038.2 HR	Unknown			

Action Required

LOW VISCOSITY OIL AND THE FUEL TEST INDICATE A HIGH LEVEL OF FUEL DILUTION. INTERVENTION IS NEEDED NOW. STOP MACHINE AND INSPECT THE ENGINE. POSSIBLE CAUSES OF FUEL DILUTION ARE: LEAKING INJECTORS, INJECTORS O-RINGS, FAILED INJECTORS, FUEL TRANSFER PUMP AND ENGINE OVERFUELING. RESAMPLE AT HALF OF NORMAL INTERVAL TO MONITOR

Wear Metals (ppm)	Cu	Fe	Cr	Al	Pb	Sn	Si	Na	K	B	Mo	Ni	Ag	Ti	V	Mn	Cd	Ca	Mg	Zn	P	Ba
D12M-50191-0002	0	1	0	0	1	1	3	0	2	6	47	0	0	0	0	0	0	837	758	1001	849	0

Oil Condition / Particle Count (ct/ml)	ST	OXI	NIT	SUL	W	A	F	PFC	V100
D12M-50191-0002	0	14	7	19	N	N	P	25.2987	8.2

Ag = Silver, Al = Aluminum, B = Boron, Ca = Calcium, Cr = Chromium, Cu = Copper, Fe = Iron, P = Phosphorus, K = Potassium, Li = Lithium, Mg = Magnesium, Mo = Molybdenum, Na = Sodium, Ni = Nickel, Pb = Lead, Si = Silicon, Sn = Tin, S = Sulphur, V = Vanadium, Zn = Zinc, A = Antifreeze, F = Fuel, W = Water, P = Positive, N = Negative, T = Trace, E = Excessive, NIT = Nitration, OXI = Oxidation, ST = Soot, SUL = Sulfation, ISO = ISO Rating, PFC = Percent Fuel Content, PQI = Particle Quantifying Index , NaW = Salt Water, FL Pt = Flash Point, TAN = Total Acid Number, TBN = Total Base Number, H2O = Karl Fisher result, V100 = Viscosity@100C, V40 = Viscosity@40C, PVI = Particle Volume Indicator

Notice: This analysis is intended as an aid in predicting mechanical wear. No guarantee, expressed or implied, is made against failure of this piece of equipment or a component thereof.

CK Power
Chris Holtgreven

FAX:
PHONE:

SAMPLE TYPE: **COOLANT - RAD_2**
SAMPLE SHIP TIME (days) : 3

COMPANY NAME : CK Power
CUSTOMER EQUIP NUM : 25Z00054
COMPARTMENT NAME : RADIATOR
SERIAL NUMBER : 25Z00054
MANUFACTURER : CATERPILLAR
MODEL : 3516
JOB SITE :
EXT WARR NUMBER :

SHOP JOB NUM :
COMP SERIAL NUM :
COMPARTMENT MODEL :
COMP MANUFACTURER :
SAMPLE LABEL NUM :
FLUID BRAND/WEIGHT :
FLUID TYPE :
EXT WARR EXPIRE DATE :
FUEL CONSUMED :

FABICK CAT
Missouri - 636-680-1500
Wisconsin - 920-498-8000

www.fabickcat.com

LAB CONTROL NUMBER	SAMPLE DATE	PROCESS DATE	EQUIPMENT METER	METER ON FLUID	FLUID CHANGED	MAKE UP FLUID	MAKE UP FLUID UNITS
D12M-50191-2001	06-Jul-2020	09-Jul-2020	1038.2 HR	1038.2 HR	Unknown		

No Action Required

PARTIALLY MAGNETIC SOLIDS MAY INDICATE LOCALIZED HOT SPOTS IN THE COOLING SYSTEM. ALL OTHER ANALYSIS READINGS ARE WITHIN THE EXPECTED RANGE FOR THIS COOLANT SAMPLE . CONTINUE TO SAMPLE AT THE RECOMMENDED INTERVAL.

Data	Al	Cu	Fe	Pb	K	Na	Sn	Zn	CaC	MgC	TH	MoO4	SiO3	BO3	PO4	BP	FP	GL	pH	CON
D12M-50191-2001	0	0	0	0	34	3774	0	0	27	4	31	610	58	44	10	107	-34	48	8.4	3663

Data	SAC	TT	CL	SO4	NO2	NO3	GLO	Odor	Color	App	Foam	Oil	PAmt	PApp	PCol	PProp
D12M-50191-2001	1247	869	17	40	557	97	290	norm	red	clear	norm	none	trace	fine	brn sol	mag

Al = Aluminum, Cu = Copper, Fe = Iron, K = Potassium, Na = Sodium, Pb = Lead, Sn = Tin, V = Vanadium, Zn = Zinc, BO3 = Borate, CaC = Ca as CaCO3, MgC = Mg as CaCO3, MoO4 = Molybdate, PO4 = Phosphate, SiO3 = Silicate, TH = Total Hardness, CL = Chloride, CO3 = Carbonate, GLO = Glycolate, NO2 = Nitrite, NO3 = Nitrate, PO4 = Phosphate, SAC = Sebacic Acid, SO4 = Sulfate, TT = Tolytriazole, BP = Boil Point(°C), FP = Freeze Point(°C), GL = Glycol, CON = Conductivity, App = Appearance, PAmt = Precipitate Amount, PApp = Precipitate Appearance, PCol = Precipitate Color, PProp = Precipitate Property,CType = Coolant Type

Notice: This analysis is intended as an aid in predicting mechanical wear. No guarantee, expressed or implied, is made against failure of this piece of equipment or a component thereof.

CK Power
Scott Egelhoff
1100 Research Blvd.
St. Louis, MO 63132

FAX:
PHONE: 314-868-8620

SAMPLE TYPE: **FUEL**

COMPANY NAME:	CK Power	SHOP JOB NUM:	
CUSTOMER EQUIP NUM:	25Z00054	CUSTOMER P O NUM:	
COMPARTMENT NAME:	FUEL SYSTEM	SAMPLE LABEL NUM:	
SERIAL NUMBER:	25Z00054	FLUID TYPE:	
MANUFACTURER:	CATERPILLAR	EXT WARR NUMBER:	
MODEL:	3516	EXT WARR EXPIRE DATE:	
JOB SITE:		FUEL CONSUMED:	

FABICK CAT

Missouri - 636-680-1500
Wisconsin - 920-498-8000

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LAB CONTROL NUMBER	SAMPLE DATE	PROCESS DATE	EQUIPMENT METER
D12M-50191-5601	06-Jul-2020	09-Jul-2020	1038.2 HR

No Action Required

SULFUR LEVEL OF THIS FUEL IS WITHIN THE LOW SULFUR DIESEL RANGE, BUT ABOVE THE ULTRA LOW SULFUR DIESEL RANGE. HIGHER SULFUR LEVELS MAY INCREASE WEAR, DEPOSIT FORMATION AND SHORTEN ENGINE OIL LIFE. PARTICLE COUNT IS WITHIN ACCEPTABLE GUIDELINES. BACTERIA AND FUNGUS ARE LESS THAN THE LOWER DETECTABLE LIMITS. OTHER ANALYSIS READINGS APPEAR TO BE ACCEPTABLE FOR DIESEL FUEL. SAMPLE AGAIN AT REGULAR INTERVAL TO MONITOR SYSTEM.

FUEL TESTS	%BIO	CI	DENS
D12M-50191-5601	0.11	51	0.82990

FUEL TESTS	VCOL	VCLA	COLO	PAmt	V40	CLBT
D12M-50191-5601	Red	clear	L3.0	none	2.5	CLEAR AND BRIGHT

FUEL TESTS	H2O	BACT	BC	FUNG	FC	VOL	SULF
D12M-50191-5601	0.0102	<LDL	<10e2	<LDL	<10e1	450	400

DISTILLATION	INIT	FINL	REC	%RES	5%	20%	30%	40%	50%	60%	70%	80%	90%	95%
D12M-50191-5601	176.7	347.7	97.8	1.7	195.9	222.5	237.0	249.8	262.0	274.3	288.1	303.7	321.8	338.5

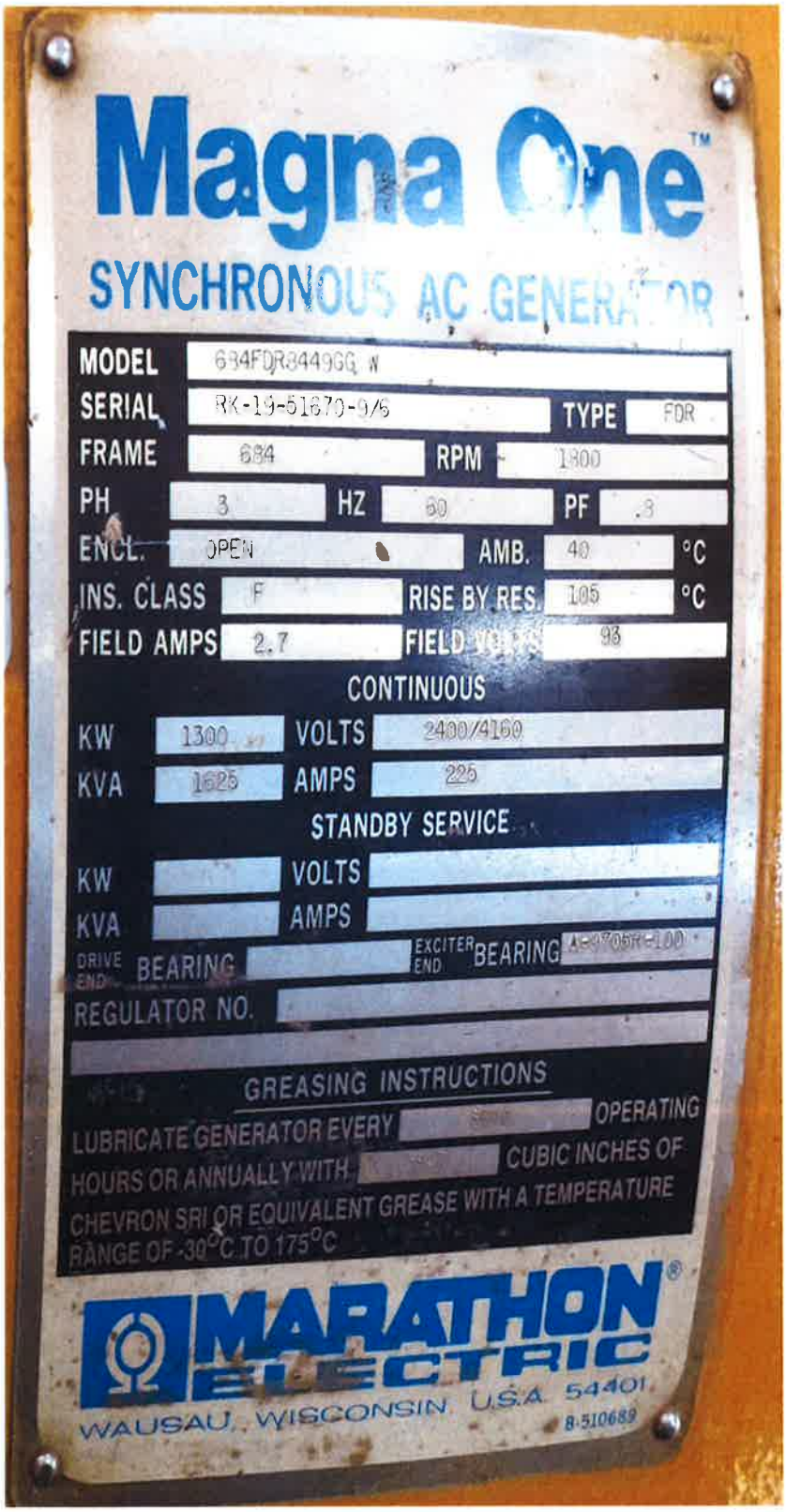
PARTICLES	ISO	4µ	6µ	10µ	14µ	18µ	21µ	38µ	50µ
D12M-50191-5601	18/14/11	1861	144	29	12	8	7	2	0

METALS	Al	Ba	B	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Mn	Mo	Ni	P	K	Si	Ag	Na	Sn	Ti	V	Zn
D12M-50191-5601	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1

Ag = Silver, Al = Aluminum, B = Boron, Ba = Barium, Ca = Calcium, Cd = Cadmium, Cr = Chromium, Cu = Copper, Fe = Iron, P = Phosphorus, K = Potassium, Mg = Magnesium, Mn = Manganese, Mo = Molybdenum, Na = Sodium, Ni = Nickel,Pb = Lead, Si = Silicon, Sn = Tin, S = Sulfur, Ti = Titanium, V = Vanadium, Zn = Zinc, ISO = ISO Rating, FLPT = Flash Point, H2O = Karl Fischer result, V40 = Viscosity at 40C, %ARO = % Aromatics, %OLE = % Olefins, %BIO = Biodiesel Content, CI = Cetane Index, CFPP = Cold Filter Plug Point, DENS = Density, VCOL = Visual Color, COLO = Color by instrumentation, VCLA = Visual Clarity, PApp = Precipitate Appearance, PAmt = Precipitate Amount, PCol = Precipitate Color, STAB = Oxidation Stability, BACT = Bacteria, FUNG = Fungus, PP = Pour Point, CP = Cloud Point, SULF = Sulfur ppm, INIT = Initial Boiling Point, FINL = Final Boiling Point, REC = Amount Recovered, %RES = % Residue, %LST = % Lost, TEMP = Temperature (°C), %TTL = % of Total Crude, PQI = Particle Quant Index, PVI = Particle Volume Index, ColMd - Color Modifier, CLBT - Clear and Bright , FH2OV = Free Water(Vol) , FH2OD = Free Water(Desc), APIG = API Gravity

Notice: This analysis is intended as an aid in predicting mechanical wear. No guarantee, expressed or implied, is made against failure of this piece of equipment or a component thereof.

Nameplate


Magna One™
SYNCHRONOUS AC GENERATOR
MODEL 684FDR3449GG
SERIAL RX-19-51670-0/5
TYPE FDR
FRAME 684
RPM 1800
PH 3
HZ 60
PF .8
ENCL. OPEN
AMB. 40 °C
INS. CLASS F
RISE BY RES. 105 °C
FIELD AMPS 2.7
CONTINUOUS
KW 1300
VOLTS 2400/4160
KVA 1625
AMPS 225
STANDBY SERVICE
KW
VOLTS
KVA
AMPS
DRIVE END BEARING
EXCITER END BEARING
REGULATOR NO.
GREASING INSTRUCTIONS
LUBRICATE GENERATOR EVERY OPERATING
HOURS OR ANNUALLY WITH CUBIC INCHES OF
CHEVRON SRI OR EQUIVALENT GREASE WITH A TEMPERATURE
RANGE OF -30°C TO 175°C
MARATHON ELECTRIC
WAUSAU, WISCONSIN, U.S.A. 54401
8-510689

CK POWER

1100 RESEARCH BLVD
ST. LOUIS, MO 63132
(314) 868-8620

Service Quote

Quote Number:		SVQ009803
Date: 07/07/20	Time: 7:31:11 AM	Status: Pending
Customer ID C05025	Contact	
Customer PO#	Customer Phone: 314-401-2096	Customer Fax:
E-Mail	segelhoff@ckpower.com	

Ship To Location:
OA- FMDC
5201 S MORLEY ST
MOBERLY, MO 65270
USA

Bill To:
OA- FMDC
301 W HIGH STREET ROOM 780
PO BOX 809
JEFFERSON CITY, MO 65102
USA

Description	Order Type	Status
ADDITIONAL WORK PER INSPECTION	CKREPAIR	Pending

PROPOSAL FOR ADDITIONAL WORK REQUIRED THAT WAS FOUND AS A RESULT OF THE COMPLETE GENERATOR ASSISMENT PERFROMED ON 7/6/20-7/8/20
UNIT HAS HAD A HISTORY OF FUEL DILUTION IN THE ENGINE OIL, DYE WAS PUT IN THE FUEL SYSTEM AND CHARGED THEN ALLOWED TO SET THEN WE CHECKED WITH THE BLACK LITE TO DETERMINE WHERE THE FUEL MAY BE ENTERING THE OIL SYSTEM. FUEL WAS FOUND TO BE LEAKING AROUND EACH INJECTOR AT THE BARRLES WHEN THE UNIT WOULD SET, THIS IS NOT UNCOMMON AS THE INJECTORS ARE ORGINAL TO THE UNIT AND HAVE NOT BEEN UPDATED WITH THE NEW SEALS TO ALLOW FOR THE LOW SULFER DIESEL SUGGESTION IS TO REPLACE ALL 16 INJECTORS ON UNIT, IT WAS ALSO NOTED THAT THE UNIT SMOKES QUITE A BIT WHILE RUNNING WITH NOT LOAD, THIS HAS MOST LIKLY CAUSED THE INJECTORS TO BUILD UP WITH HIGH AMOUNTS OF CARBON AS WELL.
DURING THE INSPECTION THE THERMOSTATES FOR THE BLOCK HEATERS WERE FOUND TO BE INOPERATBLE ONE SIDE IT COMPLETLY DISCONNECTED AND THE OTHER IS NOT CYCLING, RECOMMEND THAT BOTH BE REPLACED
BATTERIES WERE TESTED AND SEEM TO PASS THE LOAD TEST HOWEVER THE BATTEIRES ARE DATED 8/17
BATTERIES ARE RECOMMENDED TO BE REPLACED EVERY 36 MONTHS MAX ON CRITICAL SYSTEMS AS THIS.
DURING THE INSPECTION WHEN THE UNIT WAS COMMANDED TO START THE UNIT FAILED TO CRANK, TECHNICIANS SPOKE WITH OPERATERS ON SITE, THEY SOMETIMES HAVE TO WORK THE CONTROLS MANY TIMES TO GET THE UNIT TO CRANK AND RUN, UPON FUTUR INSPECTION IT WAS FOUND THAT ONE OF THE 24VDC TIMER RELAYS ON THE GENERATOR CONSOLIDATED CONTROL BOARD WAS ACTING UP, THE TIMER WAS CLEANED AND MOVED ON THE TIME SLOT TO ALLOW THE UNIT TO WORK, THE DIRECT REPLACMENT IS NO LONGER AVAIABLE HOWEVER A REPLACMENT RELAY OF SAME MAKE AND FUNCTIONS WAS FOUND AND IS PROPOSED FOR REPLACMENT. THE UNIT STARTED BUT ACTS UP ABOUT EVERY 3RD TO 4TH TRY, RELAY WILL HELP BUT WILL NOT FIX THE PROBELM, THE PCB BOARD IS OBSOLETE AND NO REPLACMENTMENT IS AVAIABLE, SUGGEST NEW STARTING CONTROLS, THIS WILL HAVE TO BE CUSTOM AND REQUIRE AN ONSITE VISIT WITH ENGINEERS TO DECIDE WHAT FUNCTIONS ARE REQUIRED BEFORE PRODUCING A PROPOSAL FOR CONTROLS.
SUGGEST REPLACING DRIVE BELTS ON ENGINE DUE TO AGE OF THEM, ALSO SUGGEST REPLACING RADIATOR CAP DUE TO AGE.
AIR FILTERS NEED REPLACED DUE TO THE AGE OF THEM, THE PAPER DEPLETES OVER TIME AND SUGGEST REPLACMENTS.

NOTE: PROPOSAL HAS BATTERIES SHOWN OF EACH BRAND, CATERPILLAR BATTERIES OR INTERSTATE BATTERIES ONLY ONE SET IS REQUIRED BUT I WANTED TO SHOW OPTIONS OF PRICING OF EACH.

Service Item No.	Serial No.	Description	Customer Unit No.
SVI076184	25Z00654	**CATERPILLAR GENERATOR**	

Labor and Materials Used:

Service Item Serial No.	Type	No.	Description	Quantity	UOM	Unit Price	Total Price
25Z00654	Item	1276260	THERMOSTAT	2.00	Each	260.26	520.52
25Z00654	Item	2949052	RADIATOR CAP	1.00	Each	111.86	111.86

25Z00654	Item	8DXHD	BATTERY (INTERSTATE)	4.00	Each	227.37	909.48
25Z00654	Item	P181126	AIR FILTER/8N6309	2.00	Each	178.23	356.46
25Z00654	Item	SUBLET	0R0906-INJECTOR A	16.00	Each	889.28	14,228.48
25Z00654	Item	SUBLET	1210172-PLATE ENGINE INFO	1.00	Each	15.97	15.97
25Z00654	Item	SUBLET	5P5678-M SEAL STK	16.00	Each	20.46	327.36
25Z00654	Item	SUBLET	8N1996-GASKET	1.00	Each	4.13	4.13
25Z00654	Item	SUBLET	FEILD LABOR FABICK INJECTOR	1.00	Each	3,625.00	3,625.00
25Z00654	Resource	FIELD EXP H	FIELD EXPENSE	1.00	Each	260.00	260.00
25Z00654	Resource	FIELD EXP S	GT5Y-IDEC TIMER RELAY	1.00	Each	58.89	58.89
25Z00654	Resource	FIELD EXP S	153-5720 8D M/F BATTERY(CAT)	4.00	Each	455.79	1,823.16
25Z00654	Resource	FIELD EXP S	B112 V-BELT	2.00	Each	70.00	140.00
25Z00654	Resource	FREIGHT	UPS GROUND	1.00	Each	30.00	30.00
25Z00654	Resource	MILEAGE	MILEAGE	300.00	Miles	2.50	750.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN injector	18.00	Hour	138.00	2,484.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN heater thermostates	3.00	Hour	138.00	414.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN batteries	3.00	Hour	138.00	414.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN air filters	1.00	Hour	138.00	138.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN belts	1.00	Hour	138.00	138.00
25Z00654	Resource	R0000	SERVICE TECHNICIAN start replay	1.00	Hour	138.00	138.00

Subtotal:	**26,887.31**
TECHNOLOGY FEE	20.00
EPA FEE	150.00
Total Quoted Price:	**27,057.31**

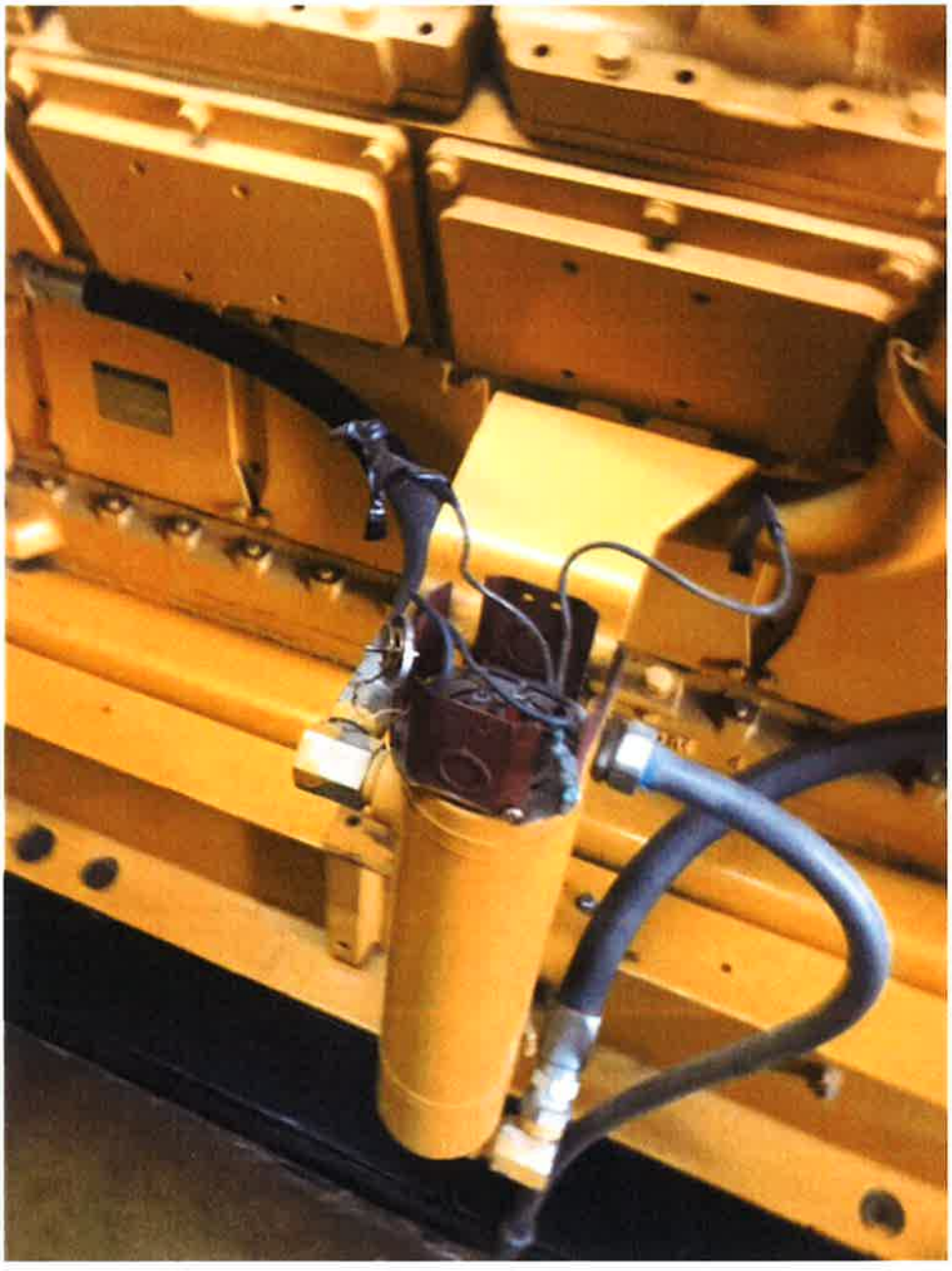
All Prices quoted are valid for 60 days from date of quote.

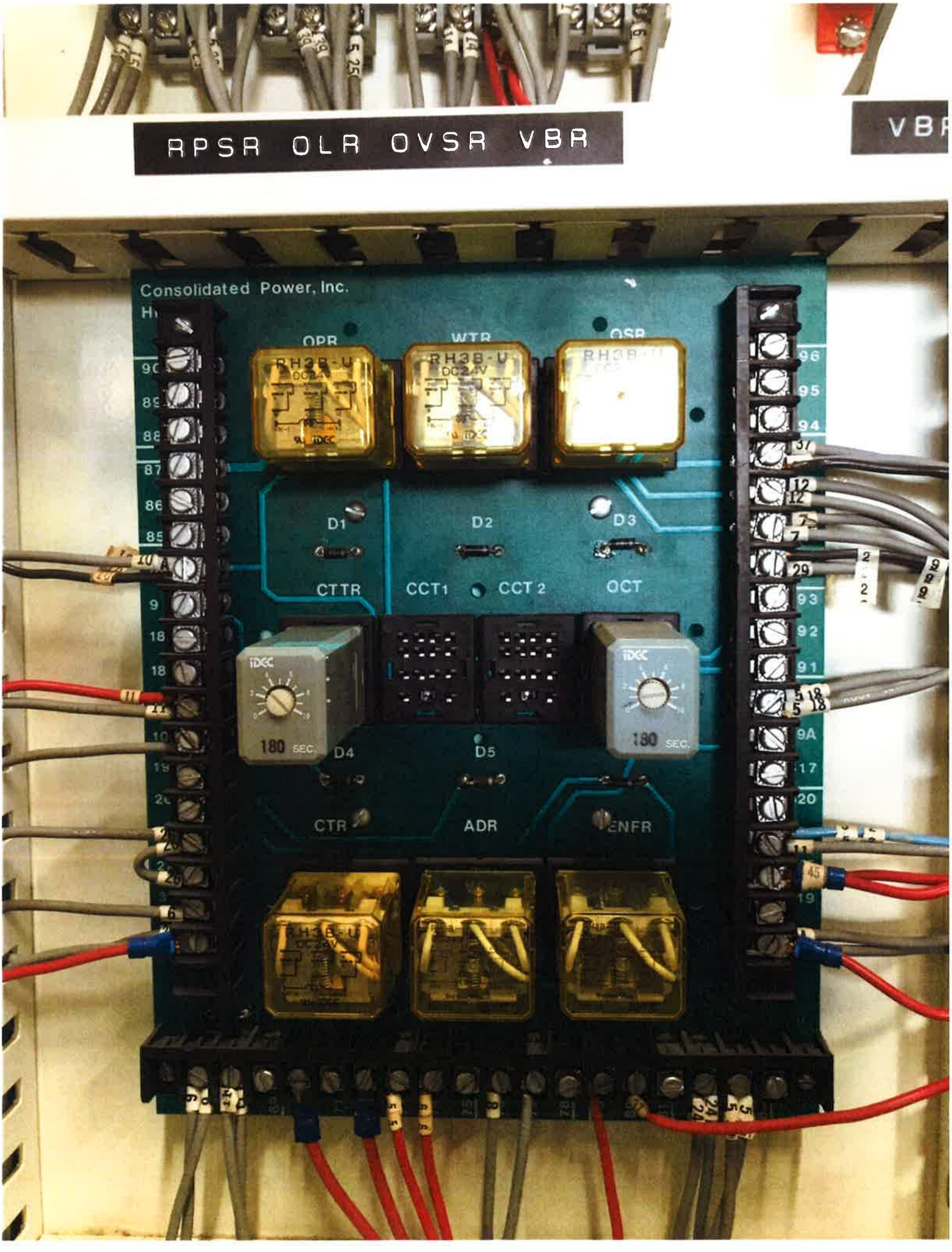
Unless Noted: This quote does not include applicable taxes, freight charges, or 3% CC transaction fee for invoices over $1,000.

Proposal Presented by: **Date:** _____

Return Signed Authorization to: **Fax:** **(314) 569-8246**

Authorized by: _____ **Date:** _____




RPSR OLR OVSR VBR
VBR
Consolidated Power, Inc.
OPR
WTR
OSR
RH3B-U
DC24V
D1
D2
D3
CTTR
CCT1
CCT2
OCT
180 SEC.
D4
D5
CTR
ADR
ENFR



CK POWER

YOUR COMPLETE SOURCE OF ENGINE AND GENERATOR POWER

OA-FMDC **9/18/2020**

5201 S Morley Street

Moberly, Missouri. 55270

Subject: Field Service Report

All;

CK Power performed proposed repairs to the unit the week of 9/14/2020 as contracted. The content of these repairs included the following services performed: replacement of all engine fuel injectors, gaskets and seals required. Re-setting the fuel delivery on the engine from 10.64 / 1556 HP to new setting as required to 16.64 /2087 HP. Re-set the valve train to specifications per caterpillar. Removed and replaced the engine high pressure fuel pump assembly and mounting gasket as directed. Installed a new Auto start/manual start PCB board in the generator control cabinet and provided a second spare as requested. Removed and installed new engine block heaters on each side with 6000 watt units as required, also installed ball valves, new fittings and new heater hoses on unit. Removed and replaced the engine cranking batteries with new 8D interstate batteries and checked operations of battery charger for proper operations. Drained out all the old coolant, during this process it was recommended that the thermostats be removed as well for engine block cooling flushing to be performed. Removed all the thermostats and filled the system with water and flush agent. Run the unit for 30 minutes then drained the water and flush agent out, re-filled with water to re-run to ensure all agent was cleaned out, during this process the water pump began to leak out of the front seal and had to be repaired. The water pump was emergency ordered for next day delivery. Removed and installed a new water pump assembly and gaskets. Installed all new thermostats and seal and gaskets as required. Replaced all Dresser coupler seals on the cooling system piping. Filled the system with new caterpillar EC coolant as directed. Replaced the cooling fan drive belts on the remote radiator as directed. Removed and replaced the fuel filters, removed and replaced the air filters on unit. Drained out engine oil and filled with new caterpillar HD 15W40 oil and replaced all engine oil filter. Started and run unit up to temperature to verify all repairs, found that the unit developed an oil leak at the turbo feed pressure lines packings, had to shut down to remove and replaced the line packings and seals. Re-started the unit and run up to temperature, verified that all repairs were good and no leaks. Installed new engine data tag with all new settings on engine block.

Now that all repairs have been verified a 4160 VAC to 480 VAC transformer was connected to the generator set with cabling of 5KV, next the transformer was connected to a 2000KW load bank for generator testing. Per specifications the unit was run under load bank testing as follows to verify the capabilities of the unit. 0% for 5 minutes for warm up, 25% @ 55 minutes, 50% @ 15 minutes then the

unit was step loaded to 100% load for 15 minutes to verify that it would pull load then the unit was dropped back down to 55% load and run for a period of 15 minutes then was step load up to 62% load, 900KW for a period of 20 minutes. Load was then dropped off unit and allowed to cool down. The transformer was disconnected and removed and the load bank as well. Unit was put back in service with limits of 900 KW availability MAX due to coolant system capabilities. Job site was cleaned up and returned back to same status prior to repairs. A new oil sample was taken for lab testing after the load test to ensure that the fuel dilution issue was resolved.

Findings during the load test are as follows:

During the load bank testing it was verified that the existing coolant system (radiator) was too small for the new HP change. The unit would only pull 62%, 900KW before overheating. The Delta "T" on the existing cooling system started at 28 degrees at 25% load and as load was increased the Delta "T" would drop. At 900 KW the Delta "T" was at 9 degrees, at 100% load it was 2 degree for the short period we ran the unit at this load thus meaning that the system would no longer cool the engine as required. CK Power had a radiator specialist visit the site prior to the load bank testing, it was verified that this remote radiator set up is not adequate for the HP/KW that is now required and will need to be upgraded. CK Power will provide a proposal for a replacement cooling package for the unit. Secondly it was found during the installations of the engine block heaters that the existing set up had 2-6000 watt heaters but being feed from one 240 vac single phase 30 amp breaker circuit. During the inspections one of the heaters were inoperable but now since both were replaced we have found that the feeder breaker keeps tripping over time, end result was found to be that the circuit was split to both heaters, this is too small as each heaters requires its own 240 vac single phase 30 amp circuit to power each heater. CK Power left one heater disconnected for now unit a new circuit can be supplied for that heater.

Load bank reports and oil sample reports have been provided per contract for review.

Scott Egelhoff

General Service Manager

segelhoff@ckpower.com

1-314-569-8276


CAT®
CORE AR
SER: NO. 25Z00654
ENGINE MODEL 3516STD
FACTORY INSTALLED
COMPRESSION BRAKE
MODIFICATION NO.
AR NO. 8N0462
PERF SPEC 0T3918
MAX ALT 3200 M FT
OEM NO.
FULL LOAD STATIC FUEL 16.64
FULL TORQ. STATIC FUEL 16.64
RATED 2087 HP 1556 kw AT 1800 RPM
BARE ENG. HIGH IDLE RPM 1819
FUEL TIMING 87.00
A/F RATIO DYNAMIC
121-0172 1

Load Bank Test Report

		Engine Model	3516d	Unit #			
		Engine Serial #	25z00654	Date of Test	9/18/2020	Air Intake Louvers	ok
		Engine Horsepower	2087	Technician	Adam	Coolant Leaks	ok
		Engine Hours	1042	Start Time	8:15AM	Oil Leaks	ok
Customer	C1920-01	Generator kW	1450	Vibrations	none	Coolant Level	full
Work Order	SVO101079	Generator Amps	251	Exhaust Leaks	ok	Oil Level	full
		Generator Voltage	4160	Intake Leaks	ok		

	Start Up	0:05	0:10	0:15	0:30	0:45	1:00	1:15	1:30	1:45	2:00
Engine Room Temperature	54	54	55	55	55	55	55	57	59	60	61
Voltage	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160	4160
Amps, Phase 1	0	52	52	52	52	52	102	203	112	125	125
Amps, Phase 2	0	52	52	52	53	52	101	202	110	125	125
Amps, Phase 3	0	52	53	52	53	53	100	202	110	125	125
Frequency, Hertz	60	60	60	60	60	60	60	60	60	60	60
kW @ 1.0 Power Factor	0	375	377	375	379	377	728	1458	797	901	901
Percent of Full Load	0	26	26	26	26	26	50	100	55	62	62
Engine Horsepower	0	502	506	502	509	506	976	1955	1069	1208	1208
Estimated Fuel Consumption	0.0	30.1	30.3	30.1	30.5	30.3	58.6	117.3	64.2	72.5	72.5
Engine Oil Pressure	83	80	75	70	63	62	60	57	58	58	58
Engine Oil Temperature	90	118	145	186	186	187	195	220	208	209	210
Engine Coolant Temperature	127	142	156	161	167	172	175	210	190	193	195
Radiator Inlet Temperature	90	130	145	160	165	170	174	208	184	189	189
Radiator Outlet Temperature	56	102	118	138	145	151	160	206	173	180	180
Radiator Delta T	34	28	27	22	20	19	14	2	11	9	9
Exhaust Temperature Right	327	545	593	603	600	612	800	1102	817	845	846
Exhaust Temperature Left	328	548	600	605	610	617	815	1108	815	850	852
Battery Charge Rate	2	2	2	2	2	2	2	2	2	2	2

	2:15	2:30	2:45	3:00	3:15	3:30	3:45	4:00
Engine Room Temperature								
Voltage								
Amps, Phase 1								
Amps, Phase 2								
Amps, Phase 3								
Frequency, Hertz								
kW @ 1.0 Power Factor	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Percent of Full Load								
Engine Horsepower	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Estimated Fuel Consumption	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Engine Oil Pressure								
Engine Oil Temperature								
Engine Coolant Temperature								
Radiator Inlet Temperature								
Radiator Outlet Temperature								
Radiator Delta T	0	0	0	0	0	0	0	0
Exhaust Temperature Right								
Exhaust Temperature Left								
Battery Charge Rate								

Comments:

Pull oil sample after completion of the 4 hour load bank test and have full lab analysis, including fuel dilution, performed. Submit lab report to Owner.

CK Power
Scott Egelhoff
1100 Research Blvd.
St. Louis, MO 63132

FAX:
PHONE: 314-868-8620

SAMPLE TYPE: **OIL**
SAMPLE SHIP TIME (days): 4

COMPANY NAME: CK Power
CUSTOMER EQUIP NUM: Moberly Correctional
COMPARTMENT NAME: ENGINE GENSET
SERIAL NUMBER: 25Z00654
MANUFACTURER: CATERPILLAR
MODEL: 3516
JOB SITE:
EXT WARR NUMBER:

SHOP JOB NUM: 100119
COMP SERIAL NUM:
COMPARTMENT MODEL:
COMP MANUFACTURER:
SAMPLE LABEL NUM:
FLUID BRAND/WEIGHT: CAT/15W-40
FLUID TYPE:
EXT WARR EXPIRE DATE:
FUEL CONSUMED:

FABICK CAT
Missouri - 636-680-1500
Wisconsin - 920-498-8000

www.fabickcat.com

LAB CONTROL NUMBER	SAMPLE DATE	PROCESS DATE	EQUIPMENT METER	METER ON FLUID	FLUID CHANGED	MAKE UP FLUID	MAKE UP FLUID UNITS	FILTER CHANGED
D12M-50266-0002	18-Sep-2020	22-Sep-2020	0	2 HR	No			No

No Action Required

READINGS APPEAR TO BE NORMAL. CONTINUE SAMPLING AT THE NORMAL INTERVAL.

B030-50003-0160	26-Dec-2019	03-Jan-2020	1034 HR	16 HR	No			No

No Action Required

WEAR PATTERN IS ACCEPTABLE AT THIS TIME. RESAMPLE AT HALF THE NORMAL INTERVAL. CONTINUE TO MONITOR COMPARTMENT BY SAMPLING AT RECOMMENDED INTERVALS.

B030-48353-0170	17-Dec-2018	19-Dec-2018	1004 HR	34 HR	No			Unknown

Action Required

FIRST SAMPLE/NO TREND ESTABLISHED. SAMPLE IS URGENTLY DILUTED WITH FUEL. LOW VISCOSITY AS A RESULT OF 23.6% FUEL DILUTION. CHECK AND REPAIR SOURCE OF FUEL ENTRY. POSSIBLE CAUSES OF FUEL DILUTION ARE: LEAKING INJECTORS, INJECTOR O-RINGS, FAILED INJECTORS, FUEL TRANSFER PUMP, AND ENGINE OVERFUELING. CONSIDER SCHEDULED INSPECTION/REPAIR/OVERHAUL. CHG OIL IF NOT ALREADY DONE. RESAMPLE IMMEDIATELY AFTER FLUID CHG FOR A BASELINE, AND AGAIN AT HALF INTERVAL.

Wear Metals (ppm)	Cu	Fe	Cr	Al	Pb	Sn	Si	Na	K	B	Mo	Ni	Ag	Ti	V	Mn	Cd	Ca	Mg	Zn	P	Ba
D12M-50266-0002	0	2	0	0	1	1	7	0	7	54	34	0	0	0	0	0	0	1373	464	977	838	0
B030-50003-0160	0	1	0	0	0	0	2	0	3	5	41	0	0	0	0	0	0	682	660	616	698	0
B030-48353-0170	0	1	0	0	1	0	3	2	1	45	36	0	0	0	0	0	0	1032	739	878	747	0

Oil Condition / Particle Count (cont.)	ST	OXI	NIT	SUL	W	A	F	PFC	V100
D12M-50266-0002	0	21	6	28	N	N	N		12.7
B030-50003-0160	0	12	6	19	N	N	N	2.8	8.3
B030-48353-0170	0	12	7	16	N	N	P	23.6	7.5

Ag = Silver, Al = Aluminum, B = Boron, Ca = Calcium, Cr = Chromium, Cu = Copper, Fe = Iron, P = Phosphorus, K = Potassium, Li = Lithium, Mg = Magnesium, Mo = Molybdenum, Na = Sodium, Ni = Nickel, Pb = Lead, Si = Silicon, Sn = Tin, S = Sulphur, V = Vanadium, Zn = Zinc, A = Antifreeze, F = Fuel, W = Water, P = Positive, N = Negative, T = Trace, E = Excessive, NIT = Nitration, OXI = Oxidation, ST = Soot, SUL = Sulfation, ISO = ISO Rating, PFC = Percent Fuel Content, PQI = Particle Quantifying Index , NaW = Salt Water, FL Pt = Flash Point, TAN = Total Acid Number, TBN = Total Base Number, H2O = Karl Fisher result, V100 = Viscosity@100C, V40 = Viscosity@40C, PVI = Particle Volume Indicator

Notice: This analysis is intended as an aid in predicting mechanical wear. No guarantee, expressed or implied, is made against failure of this piece of equipment or a component thereof.

ELECTRIC POWER SYSTEMS TESTING & ENGINEERING SERVICES

21 Millpark Ct. • Maryland Heights, MO 63043 • Phone 314.890.9999 • Fax 314.428.3062 •
www.epsii.com

Moberly Correctional Center

5201 S Morley St
Moberly, MO 65270

Generator Insulation Resistance Testing

July 6, 2020

EPS Job Number STL20136-240

Submitted by Electric Power Systems, St. Louis, MO

TABLE OF CONTENTS

Scope of Work

Procedures

Results

Data Sheet

SCOPE OF WORK

Electric Power Systems shall perform megger (polarization index) test on main stator and main rotor winding of the generator per ANSI/NETA MTS requirements in accordance with the generator manufacturer's "generator insulation testing" procedure in the O&M Manual.

Measure no load and full load exciter voltage level and exciter field resistance and megger test the generator exciter stator (field) and exciter rotor (armature) per ANSI/NETA MTS requirements in accordance with the generator manufacturer's "generator insulation testing" procedure in the O&M Manual.

Submit report based on findings and test results.

Procedures

Generator Insulation Testing

The following tests can be used to check minimum insulation resistance. Minimum insulation resistance can be tested using a megohmmeter.

Minimum insulation resistance in megohms equals the Machine Voltage divided by 1000 plus 1.

Example: 480 volt line to line generator:

Minimum insulation resistance = 480/1000 = 0.480 + 1 = 1.48 Megohms

Main Stator (Armature)

1. All stator leads must be connected together. Connect one megohmmeter lead to stator leads and the other megohmmeter lead to the generator frame. Make sure the other stator leads are not touching the frame.
   a. A reading lower than the calculated minimum indicates an unacceptably low generator insulation resistance.
   b. Clean, dry and/or repair stator - replace if necessary.

Main Rotor (Main Field)

1. Disconnect the two generator main field leads which come out through the end of the rotor shaft. These wires connect to each of the two diode heat syncs.

   Note: Make sure neither of the two leads touch any other part.

2. Apply one megohmmeter lead to one generator field lead and the other megohmmeter lead to the aluminum standoff casting (behind insulation plate on exciter rotor).
   a. A reading of less than the calculated minimum indicates an unacceptably low main field insulation resistance.
   b. Clean, dry and/or repair generator rotor - replace if necessary.

Excitor Stator (Field)

1. Disconnect exciter field leads from F+ and F- on terminal strip next to opening inside regulator box.

Note: Location and marking on wires.

2. Connect one megohmmeter lead to exciter field lead and the other to the exciter frame.
   a. A reading lower than the calculated minimum indicates an unacceptably low exciter field insulation resistance.
   b. Clean, dry and/or repair the exciter stator - replace if necessary.

Exciter Rotor (Armature)

1. Remove diode leads from studs, being certain to note the proper location for reconnection.

2. Apply one megohmmeter lead to one of the exciter rotor leads and the other lead to the aluminum standoff casting (behind insulation plate on exciter rotor).
   a. A reading of less than the calculated minimum indicates an unacceptably low exciter rotor insulation resistance.
   b. Clean, dry and/or repair the exciter rotor - replace if necessary.

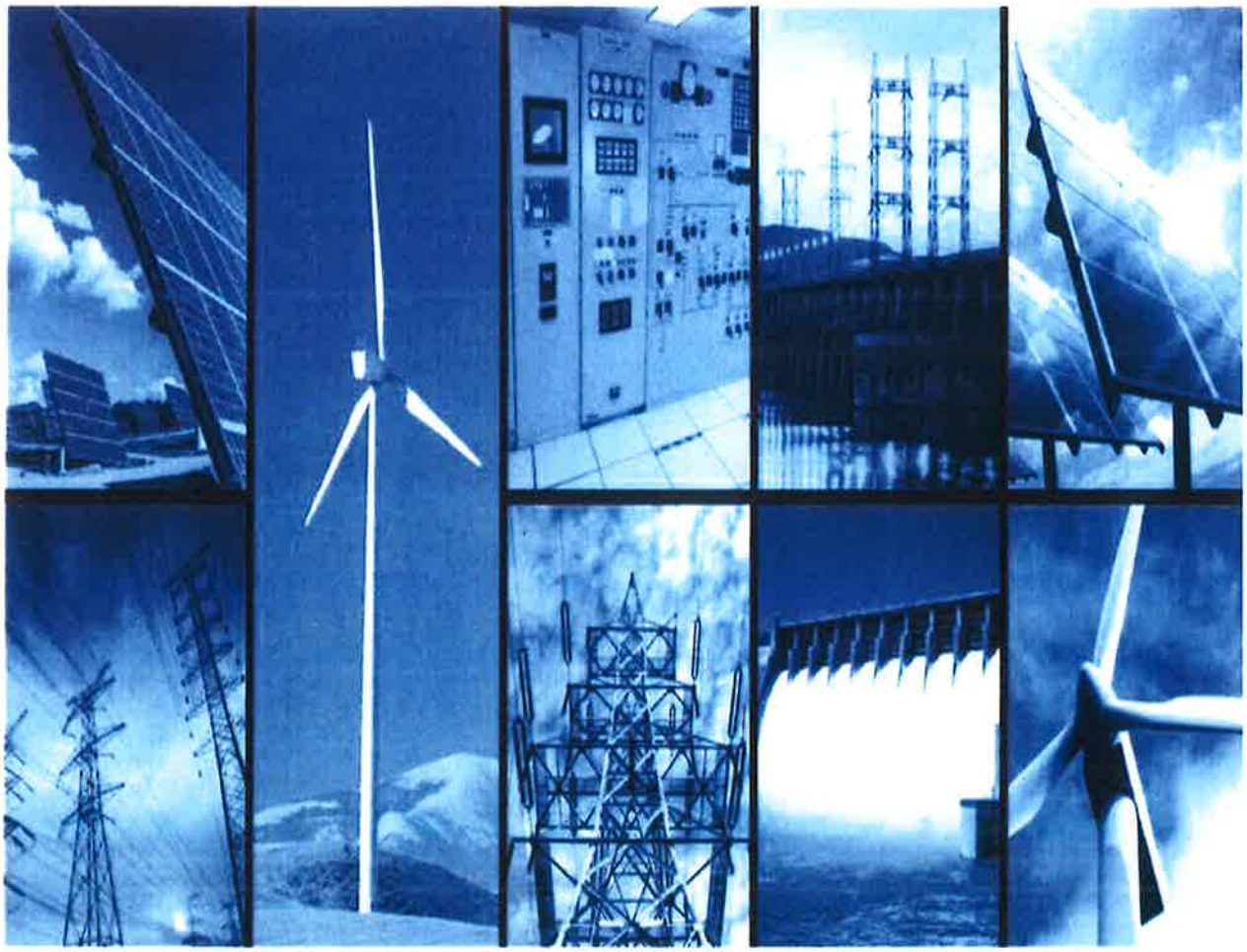
Results

The following is a summary of results, notes, and deficiencies for the tested equipment. The test data can be found in the data sheets section of this report.

All insulation resistance points tested on this generator passed. The generator is acceptable for continued use.

No load and full load exciter voltage levels were verified during startup and are listed below:
No Load Exciter Voltage = 28.60 VAC
Full Load Exciter Voltage = 91.57 VAC

DATA SHEET



Test Results

Temperature 91 F Humidity 44%

Main Stator (Armature)

Minutes	Results @ 1,000 VDC in MegOhms
0.25	525
0.5	715
0.75	817
1	881
2	972
3	1048
4	1103
5	1150
6	1191
7	1220
8	1247
9	1277
10	1298
Polarization Index	1.47

Exciter Rotor (Armature)

Minutes	Results @ 1,000 VDC in GigOhms		
	Wire 1	Wire 2	Wire 3
0.25	2.06	2.76	3.03
0.50	3.41	5.09	6.57
0.75	4.30	6.46	8.02
1	5.00	7.32	8.98
2	6.59	8.9	10.54
3	7.18	9.39	10.99
4	7.45	9.48	11.02
5	7.69	9.82	11.39
6	8.06	10.23	11.47
7	8.61	10.52	11.71
8	8.94	10.76	12.07
9	9.29	10.90	12.56
10	9.96	10.87	13.67
Polarization Index	2.09	1.48	1.55

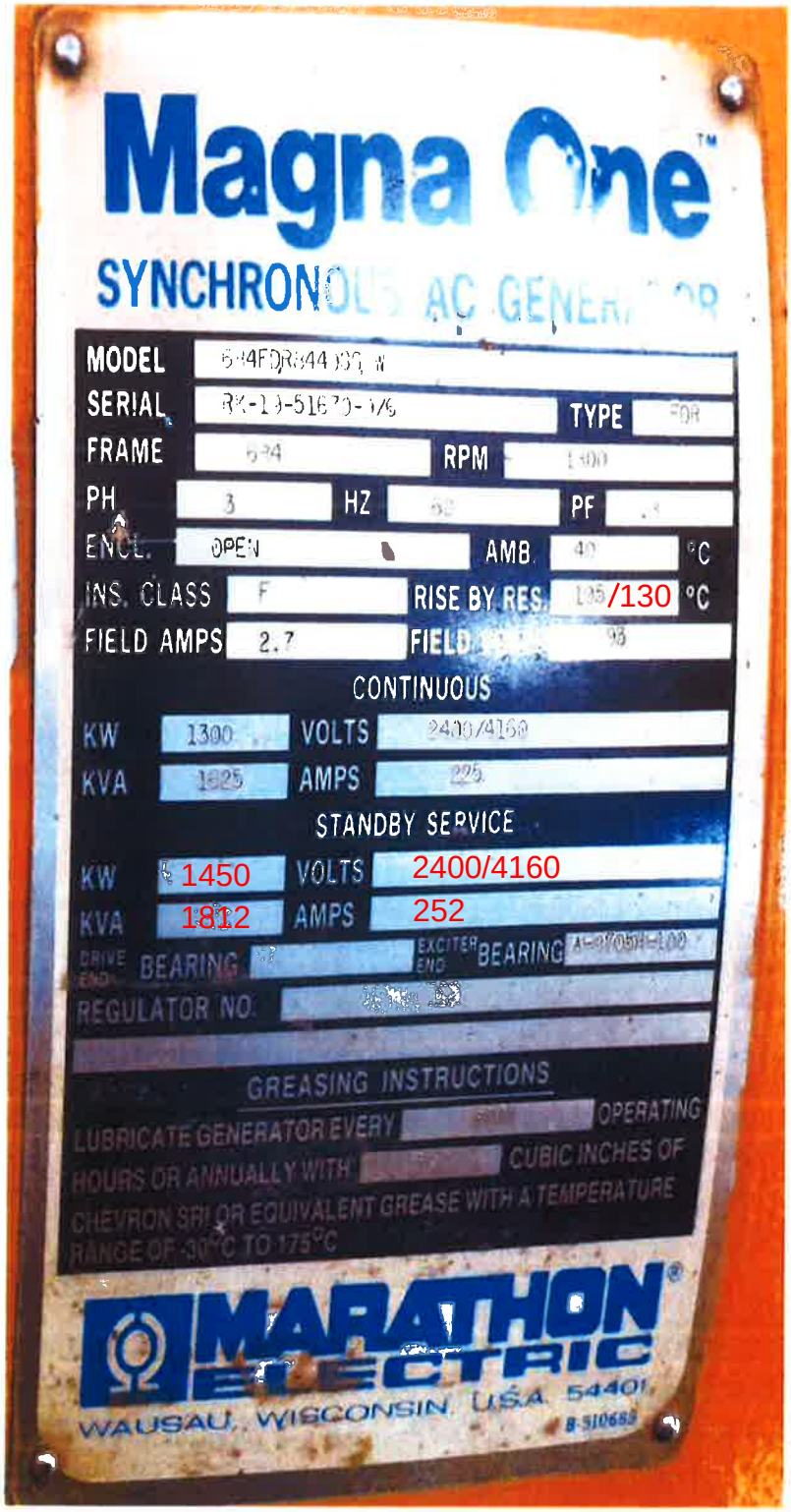
Excitor Stator (Field) – Tested @ 500 VDC for 1 minute– Results in MegOhms

F+	900
F-	900

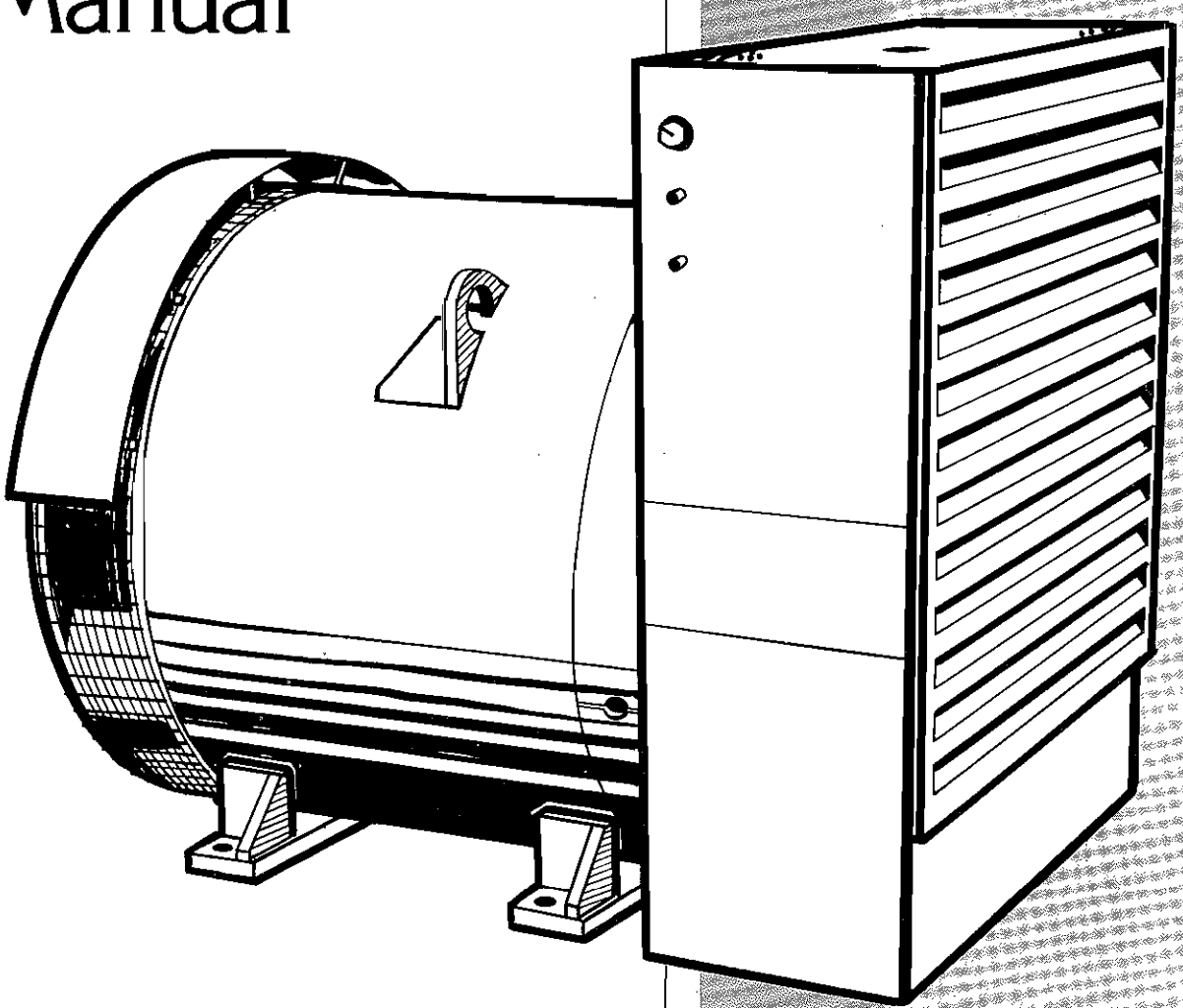
Output (4160 V wires) – Tested @ 5,000 VDC for 1 minute – Results in MegOhms

AG	482
BG	613
CG	643

Nameplate


Magna One
SYNCHRONOUS AC GENERATOR
MODEL
SERIAL
TYPE
FRAME
RPM
PH
3
HZ
PF
ENCL.
OPEN
AMB.
°C
INS. CLASS
F
RISE BY RES.
/130
°C
FIELD AMPS
2.7
CONTINUOUS
KW
1300
VOLTS
2400/4160
KVA
1625
AMPS
225
STANDBY SERVICE
KW
1450
VOLTS
2400/4160
KVA
1812
AMPS
252
DRIVE END BEARING
EXCITER END BEARING
REGULATOR NO.
GREASING INSTRUCTIONS
LUBRICATE GENERATOR EVERY
OPERATING
HOURS OR ANNUALLY WITH
CUBIC INCHES OF
CHEVRON SRI OR EQUIVALENT GREASE WITH A TEMPERATURE
RANGE OF -30°C TO 175°C
MARATHON ELECTRIC
WAUSAU, WISCONSIN, USA 54401

Magna One® Generator Installation, Operation and Maintenance Manual



This Publication is Now ***Out of Print!!***

MARATHON® ELECTRIC

WAUSAU, WISCONSIN 54401

GENERAL INFORMATION

GENERAL

A generator is a device which transforms mechanical energy into electrical energy. Magna One Generators are brushless, 4-pole machines producing 60 Hz power at 1800 rpm, or 50 Hz power at 1500 rpm (Hz = Hertz = cycles per second). All standard units are rated at 0.8 power factor.

Single bearing generators are supplied with an SAE adaptor and flexible drive discs on the drive end as standard. Alignment of the generator and engine is assured by the concentricity of the flywheel housing and the generator adaptor. Flexible drive discs are piloted in a rabbet in the flywheel itself, again assuring alignment. It may be necessary to shim the generator feet on the base for solid support. Two bearing units come standard with two brackets and a shaft extension for a drive coupling.

Ac generators require direct current flowing through the rotor winding to set up the magnetic flux which allows the unit to generate. A small ac exciter, which actually is a miniature replica of the main generator, provides this direct current. The exciter is mounted on the same shaft as the generator rotor. While the main generator field rotates and the armature is stationary, the exciter field is stationary and the armature rotates. The output from this exciter is fed into the rectifying elements mounted on a heat sink. This rectifier assembly is located on the end of the main shaft, opposite the drive end (see figure below).

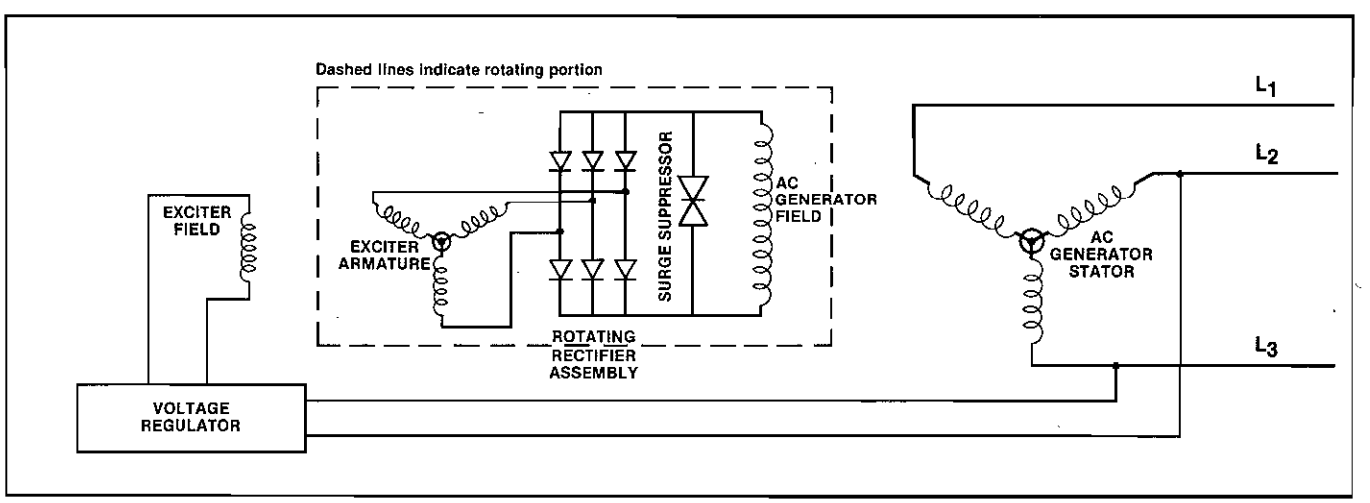
The ac exciter itself requires direct current for its excitation. This excitation is supplied by rectifying a portion of the output of the main generator by means of a static voltage regulator. The amount of current going into the field of the exciter will determine the output voltage of the exciter, and this in turn will control the output voltage of the main generator. Meters, controls, or other features needed to satisfy installation requirements are available as optional extras.

MECHANICAL CONSTRUCTION

Magna One brushless generators are designed and manufactured with the same engineering precision and craftsmanship that has, for years, gained Marathon Electric an outstanding reputation in this field. Precision machine parts, together with careful hand assembly, give the Magna One durability and reliability.

A solid, rolled steel frame, results in rigid support for the stator core and end brackets. The stator core is firmly anchored to the frame by the welding of bar steel core supports to the core and frame.

The end brackets and adaptors are made of cast iron for the ultimate rigidity required to support the heavy duty shielded bearings. A front bracket supports the stationary exciter field structure. For single bearing units, the frame is fitted with a rugged cast iron SAE adaptor, precision rabbeted to insure alignment with the prime mover. A nodular iron hub is keyed and heat shrunk to the shaft. This hub carries a number of flexible steel drive discs which have holes for fastening to the flywheel (for some adaptor-disc combinations a spacer is used between the hub and discs to maintain the proper distance between the discs and SAE adaptor face). This affords flexibility, in the axial direction, while in the radial direction it acts as a rigid coupling providing a uniform air gap.



GENERAL INFORMATION

For two bearing generators, a second bracket and standard shaft extension is substituted for the adaptor and flexible drive discs. The 360 and 440 Frames are available with long shaft extensions for belt drive applications while all frame sizes are suitable for coupled drive. When selecting a belt driven generator, refer to the chart on Page 6 for the drive details under which these units will operate successfully.

UNIROTOR™ CONSTRUCTION

A unique feature of the Magna One generator is that the amortisseur winding and coil supports are die cast as an integral part of the rotor. The 4 poles which carry the field windings are one piece laminations die cast with aluminum providing high mechanical integrity, and low vibration at operating speeds. This method has been time proven to be far superior to separate pole pieces which must be dovetailed to a spider or fastened by screws to the shaft.

The rotor pole assembly is heat shrunk and keyed to the shaft, forming a very rigid rotating element.

A thermo-setting bonding epoxy is applied between layers of the field winding and is applied to the finished rotor. The completed rotor is baked under a controlled cycle to ensure a solid, mechanically stable rotor. All rotors are dynamically balanced and then tested at a speed of 125% of the operating speed.

The ac exciter armature and the heat sink which carries the diodes are mounted on an assembly which is placed on the generator shaft outboard of the front generator bearing.

STATOR

The stator laminations are composed of thin, low-loss steel, notched on precision presses. The cores are reinforced by rugged steel stack rings and supporting bars which are welded around the core. Up to 600 volts, random-wound coils are placed in slots insulated with Class F materials. Once the properly insulated coils have been inserted in the stator core, the entire core is then given multiple dips and bakes in a thermo-setting varnish by a special process which ensures complete coverage. This premium insulation system utilizes all synthetic and non-hygroscopic materials making the standard windings fungus resistant and suitable for operation in high humidity and abrasive environments. Subsequently, the wound core is placed into and welded to the frame.

VENTILATION SYSTEM

Magna One generators employ an advanced flow-through ventilation system. The cast aluminum alloy ventilating fan draws air through louvers in the conduit box, over the main stator and exciter windings and exhausts it through ventilation screens in the adaptor. This exclusive design provides efficient cooling as air is distributed evenly throughout the generator, effectively reducing the recirculation of hot air. Since there is only one air intake, mounting of air filtration systems is easily accomplished.

ELECTRICAL CONNECTIONS

The large front end mounted conduit box is constructed of formed sheet steel with ample room inside for the voltage regulator, most circuit breakers and other options. A hole-saw or any suitable tool can be used to provide a hole for the conduit entrance. An approved connector must be used in conjunction with the conduit. The regulator can be moved from the left to the right side with relative ease if the entrance of the conduit is needed in this location.

IMPORTANT: To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical connections to the generator. Refer to the connection diagrams supplied with the generator and install all intercomponent and external wiring in accordance with the regulations of the national and local regulatory bodies. Be sure the generator frame is grounded to all the other components of this system with the ground wire complying with national and local codes. Terminal lugs① are provided on all low voltage (below 600 volts) generators except 682 frames where buss bars are used. Above 600 volts, terminal lugs① are used exclusively. Clean all contact surfaces to assure good electrical bonding with the generator lugs or buss bars. Use heavy duty terminal lugs or good quality clamps for making all connections. Tape all connections in accordance with national and local regulations.

①CSA certified terminal lugs are used.

INSTALLATION

RECEIVING YOUR MAGNA ONE GENERATOR

Upon receipt of the generator, it is recommended that it be carefully examined to determine if any shipping damage has occurred before accepting the shipment from the transportation company.

UNPACKING AND HANDLING

Read all instruction cards carefully. When lifting, attach an overhead crane to the lifting lugs on the generator frame. Apply lifting forces in a vertical direction, if possible.

WARNING

DO NOT LIFT COMPLETE GENERATOR SET BY MEANS OF LIFTING LUGS ON GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

WARNING

DO NOT APPLY ANY FORCE TO GENERATOR FAN FOR LIFTING OR ROTATING GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

STORAGE

In the event that the generator is not to be installed on the prime mover immediately, it is recommended that it be stored in a clean, dry area which is not subject to rapid changes in temperature and humidity.

INSPECTION

It is recommended that the insulation resistance of the generator stator be checked with a megohmmeter prior to initial operation. In order to do this, all stator leads must be connected together and the insulation resistance measured from the lead terminals to the stator frame. Make certain the stator leads are not touching the frame. A megohm reading should be obtained that is equal to or greater than the following formula:

$$\text{Minimum Megohms} = \frac{\text{Rated Voltage}}{1000} + 1$$

An insulation resistance greater than the minimum indicates the insulation is in good condition. (NOTE: 1 megohm = 1,000,000 ohms.) A record should be kept of the resistance readings for comparison with future data. A drop in resistance values indicates wet, dirty or grounded insulation. In this case, clean and dry the winding using one of the listed methods on the following pages and check for grounds following the instructions in the "GENERATOR INSULATION TESTING" section.

CAUTION: READ THE "GENERATOR INSULATION TESTING" SECTION THOROUGHLY BEFORE USING A MEGGER ON THE ROTOR OR EXCITER FIELD. EXTENSIVE EQUIPMENT DAMAGE CAN RESULT FROM IMPROPER TESTING.

INSTALLATION

MOISTURE REMOVAL

Machines that have been idle for sometime in unheated and damp locations, may have "sweated" as a result of sudden changes in temperature or may have become wet by accident. These should be dried out thoroughly before being put into service. The following are recommended drying methods.

Oven

Place the machine in an oven and bake it at a temperature not to exceed 90 degrees C or 194 degrees F. The voltage regulator and any electronic component accessories must be removed from the generator when using this method.

Space Heaters

Enclose the generator with a covering and insert heating units (space heaters, lamps or coils of steam pipe) to raise the temperature. Leave a hole at the top of the enclosure to permit the escape of moisture.

Forced Air

A portable forced air heater can be used by directing heat to the end of the generator opposite the coupling and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuses). Heat at point of entry should not exceed 66 degrees C (150 degrees F) at the bearing hub.

"Short Circuit" Method

The Generator can be dried out quickly and thoroughly by using this method. NOTE: Be sure that all of the following steps are performed and all precautions taken as personal injury or serious damage to the generator could result.

1. Disconnect exciter leads F1 and F2 from the terminal block.
2. Connect a dc battery or other dc power source of approximately 20-35 volts (depending on the kW of your unit) to the exciter leads F1 and F2. An adjustable voltage source is desirable, however a voltage adjust rheostat (rated approximately 2 amps) in series with the dc power source will accomplish the same result.
3. Short circuit the generator lead wires to each other (L1 to L2 to L3).
4. Start the generator and measure the current through the leads with a clip-on ammeter.
5. Adjust the voltage source to produce approximately 80% of the rated ac nameplate current, but in no case exceed nameplate amps. If an adjustable source is not available and current is excessive, use a small dc source or a large resistor in series with the source.

   Running time will be determined by the amount of moisture present in the machine. Insulation resistance checks should be taken every one to four hours until a fairly constant value is obtained, equal to or greater than the following formula:

$$\text{Megohms} = \frac{\text{Rated Voltage}}{1000} + 1$$

6. After machine has achieved a constant resistance value, disconnect the dc power source and reconnect F1 from the exciter to F(+) on the terminal block, and F2 to F(-). Make sure that all leads are reconnected properly.

If it is necessary to dry out the generator, it is recommended that the unit be thoroughly tested using the "Generator Insulation Testing" procedures found on the next page.

GENERATOR INSULATION TESTING

The following tests can be used to check minimum insulation resistance. Minimum insulation resistance can be tested using a megohmmeter.

CAUTION: MEGOHMMETER MUST NEVER BE APPLIED TO VOLTAGE REGULATOR OR DIODES - EQUIPMENT DAMAGE WILL RESULT.

$$\text{Minimum insulation resistance in megohms} = \frac{\text{Machine Voltage}}{1000} + 1$$

Example: 480 volt line to line generator:

$$\text{Minimum Insulation Resistance} = \frac{480}{1000} + 1 = 1.48 \text{ Megohms}$$

MAIN STATOR (ARMATURE)

1. All stator leads must be connected together. Connect one megohmmeter lead to stator leads and the other megohmmeter lead to the generator frame. Make sure the other stator leads are not touching the frame.

   a. A reading lower than the calculated minimum indicates an unacceptably low generator insulation resistance.

   Clean, dry and/or repair stator, replace if necessary.

MAIN ROTOR (MAIN FIELD)

1. Disconnect the two generator main field leads which come out through the end of the rotor shaft. These wires connect to each of the two diode heat sinks.

   NOTE: Make sure neither of the two leads touch any other part.

2. Apply one megohmmeter lead to one generator field lead and the other megohmmeter lead to the aluminum standoff casting (behind insulation plate on exciter rotor).

   a. A reading of less than the calculated minimum indicates an unacceptably low main field insulation resistance.

   Clean, dry and/or repair generator rotor, replace if necessary.

EXCITER STATOR (FIELD)

1. Disconnect exciter field leads from F+ and F- on terminal strip next to opening inside regulator box.

   NOTE: Location and markings on wires.

2. Connect one megohmmeter lead to exciter field lead and the other to the exciter frame.

   a. A reading lower than the calculated minimum indicates an unacceptably low exciter field insulation resistance.

   Clean, dry and/or repair the exciter stator, replace if necessary.

EXCITER ROTOR (ARMATURE)

1. Remove diode leads from studs, being certain to note the proper location for reconnection.

2. Apply one megohmmeter lead to one of the exciter rotor leads and the other lead to the aluminum standoff casting (behind insulation plate on exciter rotor).

   a. A reading of less than the calculated minimum indicates an unacceptably low exciter rotor insulation resistance.

   Clean, dry and/or repair the exciter rotor, replace if necessary.

INSTALLATION

PREPARATION FOR USE
GENERATOR MOUNTING

PREPARATION FOR USE

Although the generator is carefully inspected and tested in operation before it leaves the factory, it is recommended that the unit be thoroughly inspected. The insulation on the wire should be inspected and all bolts should be checked for tightness.

Remove all shipping tapes, bags, blocks and skids which are used to prevent vibration and rotor movement during shipment. Dry, low-pressure compressed air of approximately 30 PSI (206 KPA) can be used to blow out the interior of the generator. In the case of two bearing machines, it is possible to turn the rotor by hand to make sure that it rotates smoothly without binding.

If the machine has been in storage for a year or longer, it is recommended that it be lubricated according to the lubrication instructions and chart found in the "Lubrication" section of this manual.

GENERATOR MOUNTING

Single bearing generators are provided with an SAE flywheel adaptor and flexible drive discs. Very close tolerances are maintained in the manufacture of the generator so that the alignment procedure is extremely simple. A coupling hub of nodular iron is shrunk on the shaft and special steel drive discs are bolted to the hub. Holes are provided in the periphery of the coupling disc which correspond to tapped holes in the flywheel. The outside diameter of the discs fits in a rabbet in the flywheel so that concentricity is assured in all cases.

CAUTION: GRADE 8 CAPSCREWS AND HEAVY SERIES LOCKWASHERS OR GRADE 8 PLACE-BOLTS AND HARDENED WASHERS ARE RECOMMENDED TO MOUNT THE DRIVE DISCS TO THE FLYWHEEL.

The SAE adaptor and the flywheel housing are designed to match each other with no further alignment necessary. Shims may be necessary under the feet of the generator to insure a solid mounting.

TWO BEARING GENERATOR MOUNTING

Two bearing generators are provided with a shaft extension and keyway. For direct-coupled units, the assembler furnishes a flexible coupling which is installed between the driver and the generator shaft.

IMPORTANT: Aligning the two machines as accurately as possible will reduce vibration and insure minimum coupling wear. It may be necessary to shim the generator feet for proper support.

BELT DRIVE

360 and 440 frame, two bearing generators can be belt driven. Please refer to Marathon Electric for application assistance involving belt driven installations. Sheave diameters should be chosen according to the table below.

Magna One Sheave Application for Two Bearing Units①

Model	Min. Sheave Dia. in Inches @ 10,000 Hr. B-10 Life③		Min. Sheave Dia. in Inches @ 20,000 Hr. B-10 Life③		Max. Sheave Width Inches
	60 Hz	50 Hz	60 Hz	50 Hz	
360FDR8500	7.1	6.0	9.5	8.1	5.88
360FDR8504	7.9	6.7	10.4	8.7	5.88
362FDR8508	8.7	7.7	11.8	10.3	5.88
362FDR8512	12.2	10.0	16.8②	13.7	5.88
440FDR8016	10.2	8.5	13.7②	11.3	8.50
440FDR8020	12.7	11.2	17.2②	15.1	8.50
440FDR8024	14.4	12.4	19.6②	16.9②	8.50

①Assumptions:
A. Belting factor is 1.3.
B. The drive and the driven sheaves are the same diameter.
C. The sheave load is located at the center of the shaft extension.
D. Based upon continuous kW ratings.

② These sheave diameters exceed the maximum recommended belt speed of 6000 ft/min.
③ B-10 Life means 90% of the bearings will last this long or longer.

GENERATOR LEAD CONNECTIONS

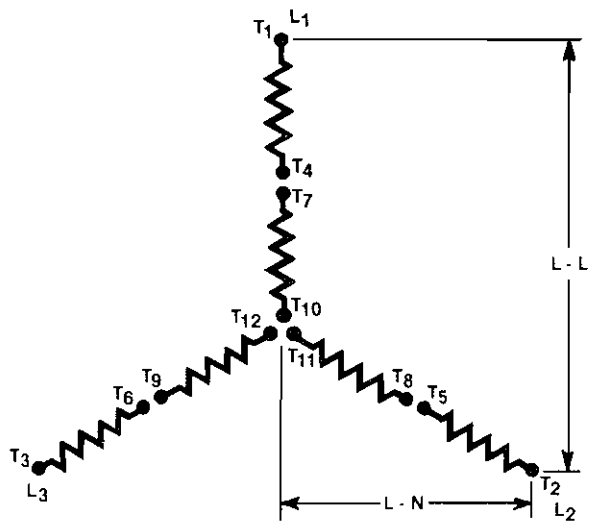
The electrical connections in the conduit box should be made in accordance with the appropriate "connection diagram." Use the diagram appropriate for the number of leads and voltage range required.

The final voltage setting is established within the selected range by an adjustment of the voltage regulator.

The use of flexible conduit is required to minimize the effect of the engine vibrations.

CAUTION: SOME GENERATORS HAVE MULTIPLE, IDENTICALLY MARKED, CABLES FOR EACH LEAD. CONNECT ALL IDENTICALLY MARKED CABLES TOGETHER WHEN MAKING CONNECTION TO LOAD.

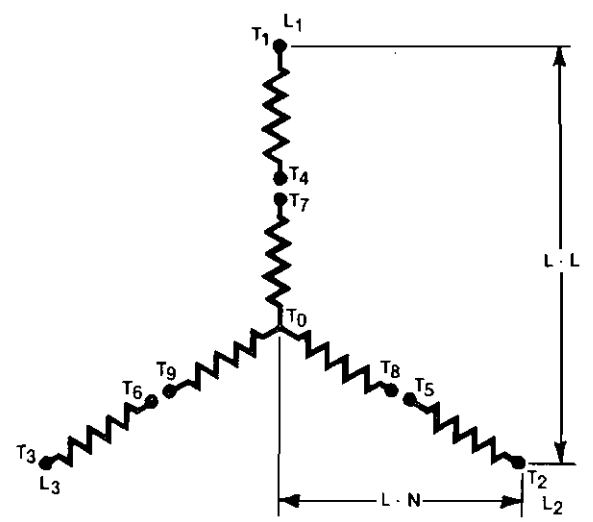
12 LEAD HI WYE



Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	380 416 440 460 480	219 240 254 266 277	T_{10} T_{11} T_{12}	T_1	T_2	T_3	T_{10} T_{11} T_{12}
			T_4 T_7				
			T_5 T_8				
50 HZ	380 400 416	219 231 240	T_6 T_9				

10 LEAD HI WYE



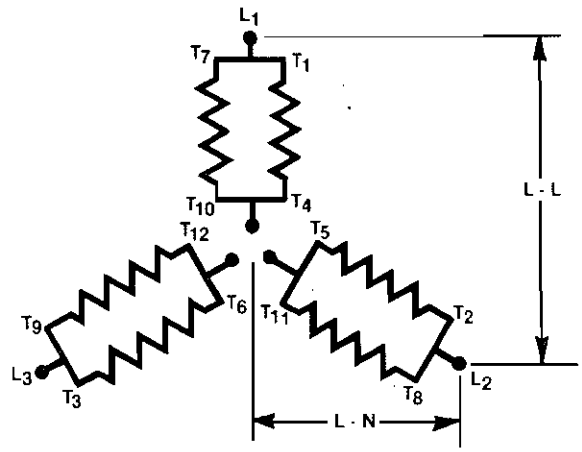
Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	380 416 440 460 480	219 240 254 266 277	T_4 T_7	T_1	T_2	T_3	T_0
			T_5 T_8				
			T_6 T_9				
50 HZ	380 400 416	219 231 240					

INSTALLATION

ELECTRICAL CONNECTIONS

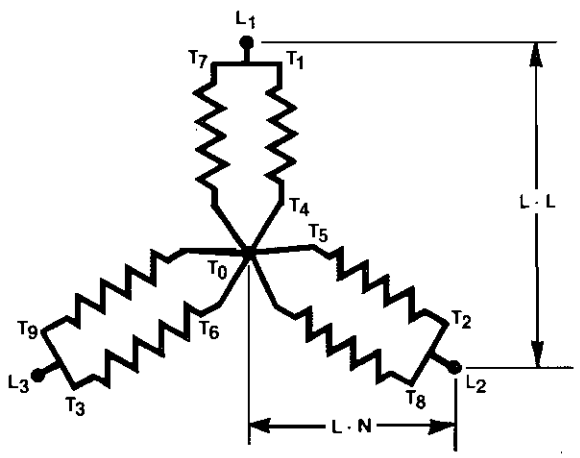
12 LEAD LOW WYE



Twelve lead generators are dual voltage generators with six coils which don't have the connection of the three inner coils. There are 12 or 24 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	190 208 220 230 240	110 120 127 133 139	T_{10} T_{11} T_{12} T_4 T_5 T_6	T_1	T_2	T_3	T_{10} T_{11} T_{12} T_4 T_5 T_6
			T_1 T_7				
50 HZ	190 200 208	110 115 120	T_2 T_8				
			T_3 T_9				

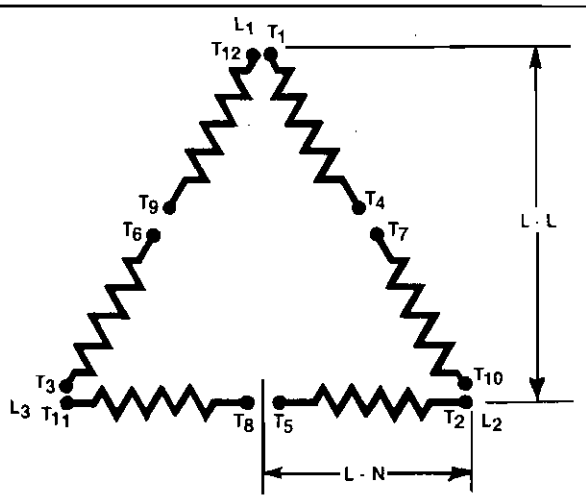
10 LEAD LOW WYE



Ten lead generators are dual voltage generators with six coils. One end of the three inner coils is connected together. There are 10 or 20 cables coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	190 208 220 230 240	110 120 127 133 139	T_1 T_7	T_1	T_2	T_3	T_4 T_5 T_6 T_0
			T_2 T_8				
			T_3 T_9				
50 HZ	190 200 208	110 115 120	T_4 T_5 T_6 T_0				

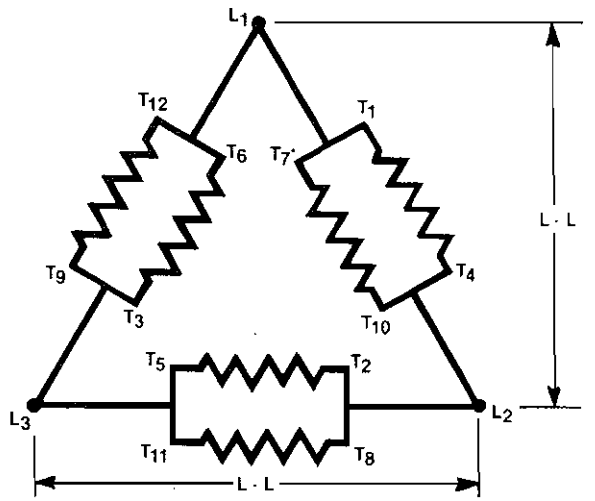
12 LEAD HI DELTA



Delta connection with 12 lead generators only.

VOLTAGE			CONNECT	L_1	L_2	L_3
	L-L	L-N				
60 HZ	240 277	120 139	T_4 T_7	T_1	T_2	T_3
			T_5 T_8			
50 HZ	200 220 240	100 110 220	T_6 T_9			
			T_1 T_{12}			
			T_2 T_{10}			
			T_3 T_{11}			

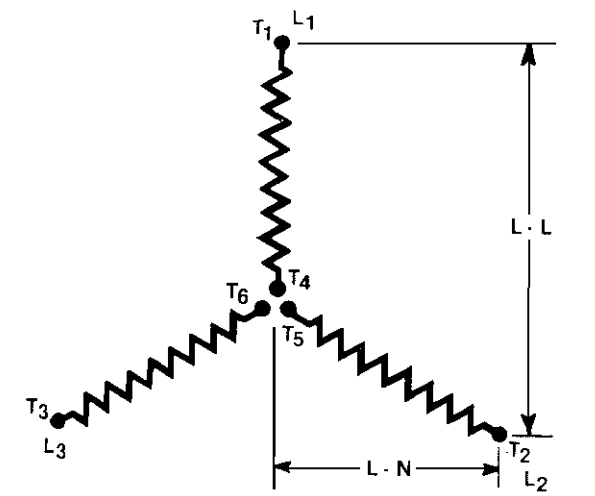
12 LEAD LOW DELTA



Delta connection with 12 lead generators only.

VOLTAGE		CONNECT	L_1	L_2	L_3
	L-L				
60 HZ	120 139	T_1 T_7 T_6 T_{12}	T_1	T_2	T_3
		T_2 T_8 T_4 T_{10}			
50 HZ	100 120	T_3 T_9 T_5 T_{11}			

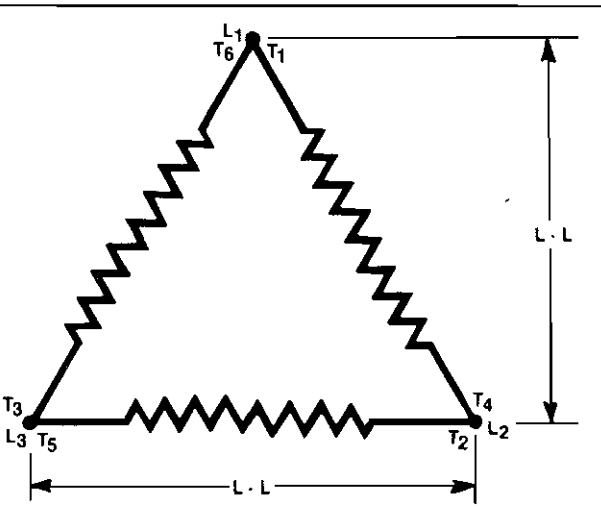
6 LEAD WYE



Six lead generators have 3 coil groups with 6 or 12 cables or bus bars coming out of the generator.

VOLTAGE			CONNECT	L_1	L_2	L_3	NEUTRAL
	L-L	L-N					
60 HZ	190 203 220 230 240 3300 4160	110 120 127 133 139 1905 2400	T_4 T_5 T_6	T_1	T_2	T_3	T_4 T_5 T_6
50 HZ	190 200 208 3300	110 115 120 1905					

6 LEAD DELTA



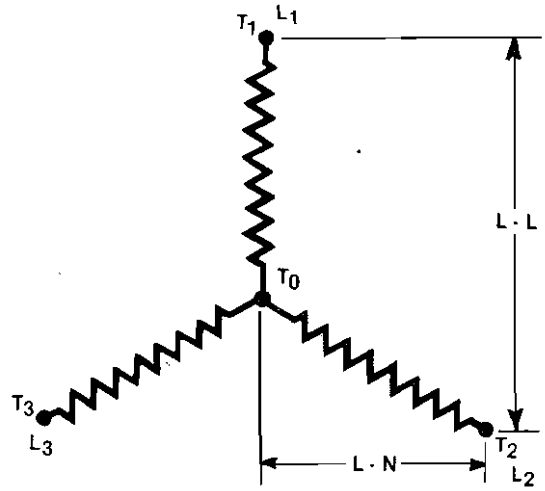
Six lead generators have 3 coil groups with 6 or 12 cables coming out of the generator.

VOLTAGE		CONNECT	L_1	L_2	L_3
	L-L				
60 HZ	2400	T_1 T_6	T_1	T_2	T_3
		T_2 T_4			
50 HZ	1905	T_3 T_5			

INSTALLATION

ELECTRICAL CONNECTIONS

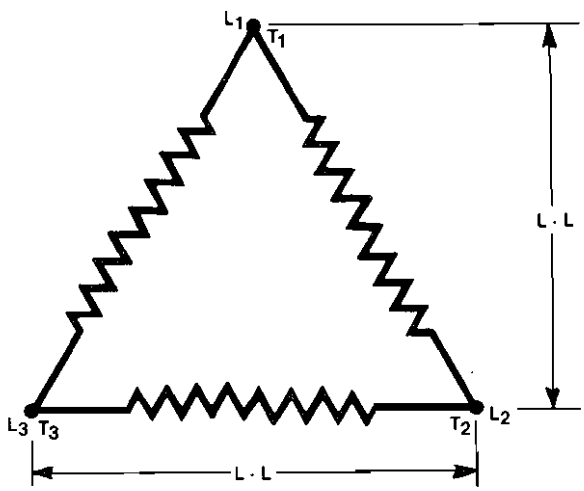
4 LEAD WYE



Four lead generators have 3 coil groups with one end of each group connected together. There are 4, 8 or 16 cables or 4 bus bars coming out of the generator.

VOLTAGE			L_1	L_2	L_3	NEUTRAL
	L-L	L-N				
60 HZ	380	219	T_1	T_2	T_3	T_0
	416	240				
	440	254				
	460	266				
	480	277				
	600	346				
50 HZ	380	219				
	400	231				
	416	240				
	480	277				

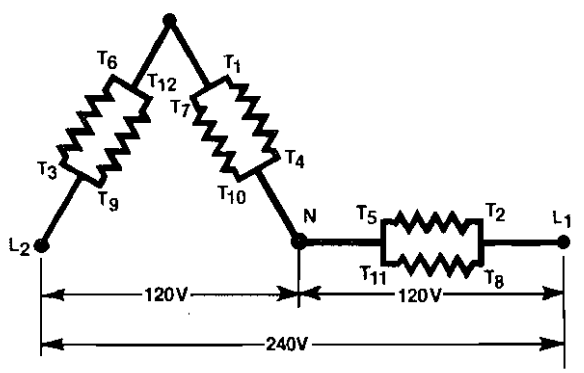
3 LEAD DELTA



Three lead generators have 3 coil groups with one end of each group connected into a Delta internally. There are 3, 6, or 12 cables or 3 bus bars coming out of the generator.

VOLTAGE		L_1	L_2	L_3
	L-L			
60 HZ	480	T_1	T_2	T_3

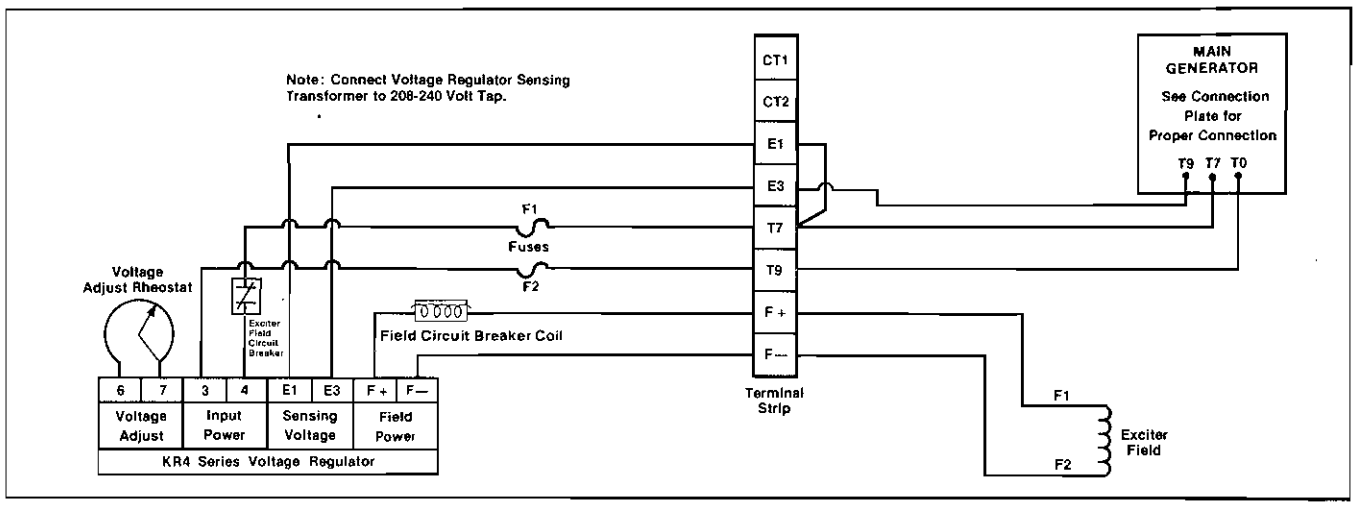
12 LEAD ZIG-ZAG



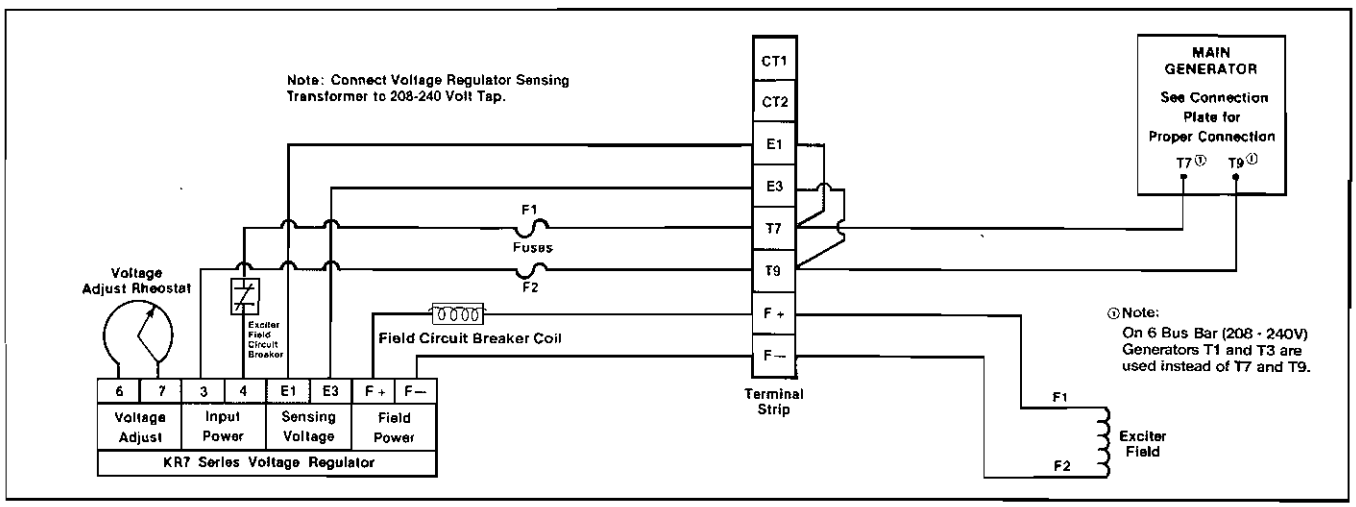
ZIG-ZAG connection with 12 lead machine only.

VOLTAGE		CONNECT	L_1	L_2	NEUTRAL
	L-L				
60 HZ	120/240	T_3 T_9	T_2	T_3	T_4
		T_2 T_8			
		T_1 T_6 T_7 T_{12}			
		T_4 T_{10} T_5 T_{11}			

VOLTAGE REGULATOR CONNECTION DIAGRAM - KR4 SERIES (208-240 VOLT TAP)



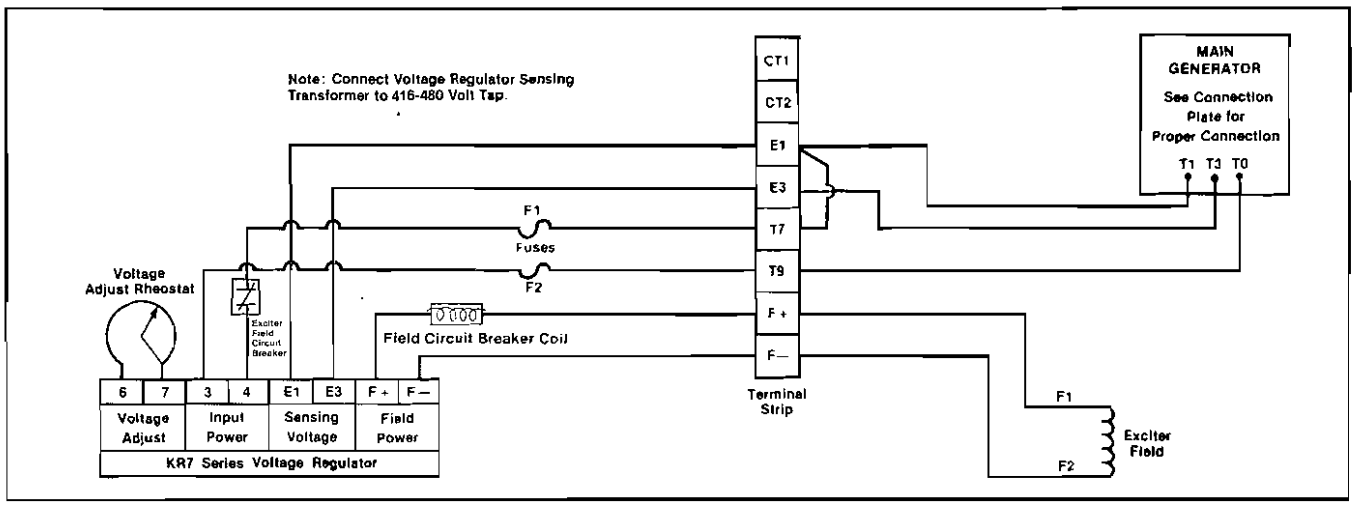
VOLTAGE REGULATOR CONNECTION DIAGRAM - KR7 SERIES (208-240 VOLT TAP)



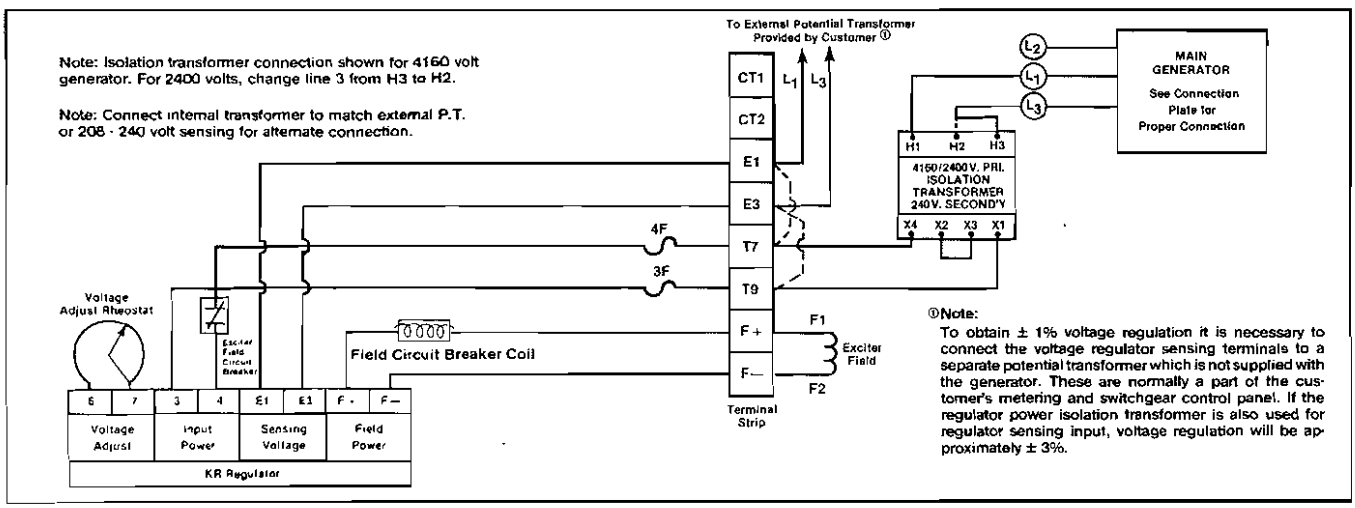
INSTALLATION

ELECTRICAL CONNECTIONS

VOLTAGE REGULATOR CONNECTION DIAGRAM - KR7 SERIES(416-480 VOLT TAP)



VOLTAGE REGULATOR CONNECTION DIAGRAM - KR7F SERIES (4160/2400 VOLT)



PARALLELING OPERATIONS

Magna One generators come standard with amortisseur windings die cast as an integral part of the rotor. This exclusive Unirotor construction makes all Magna One generators suitable for paralleling operations when the proper control equipment is added.Paralleling with other generator sets and/or with the utility power grid offers a number of advantages. Multiple unit installations increase power capacity; they can be added or removed from the load depending on the load required; they can be better maintained and repaired (since single source breakdown would mean total loss of power) and they often provide more reliable, efficient and economical operation.

Successful parallel operation means that the generators deliver power to the external system without delivering power to each other, or accepting power from the load buss or power grid. Additional equipment is necessary to insure safe and successful operation.

PRIME MOVER

The prime mover provides the speed and torque which will be necessary to keep the machines in synchronized operation. The speed will directly control the watt or kW load and frequency of the unit. The prime mover speed is controlled by a governor. The governor must have special paralleling and droop provisions to permit parallel operation with other machines.

VOLTAGE REGULATOR

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more ac generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to permit it to control the reactive or VAR load while it is in parallel operation. A separate paralleling current transformer is required to sense the reactive current and signal the voltage regulator. This additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

SWITCHGEAR

There are additional relays and breaker controls which are necessary to insure safe, trouble free operation of paralleled units. Reverse power relays monitor the direction of power flow to insure that the generator is delivering power, not accepting it. These power relays control breakers, which are a means of connecting and disconnecting the generator from the load. The total system can include over-voltage, over-current protection, under frequency protection, power factor correction provision and various associated control equipment from manual switchgear to micro-processors. The amount of control gear and level of sophistication will be determined by the needs and requirements of the particular application.

PARALLELING BASICS

The following points are basic criteria which must be met before two units can be paralleled. THIS IS NOT MEANT TO BE SPECIFIC INSTRUCTIONS FOR PARALLELING OPERATION.

1. Additional paralleling circuitry

   A. Voltage regulator - paralleling provisions

   B. Paralleling current transformers(s)

   C. Paralleling provisions on governor controls

   D. Switchgear

2. The voltage and frequency must be the same for all sets with voltages in phase.

3. The voltage regulation characteristics of the individual generators should be similar.

4. The generators must have the same phase rotation.

5. The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation.

Before operating generator sets in parallel, each set should be checked by starting, operating and adjusting the sets as individual units before attempting paralleling.

INSTALLATION

PARALLELING OPERATIONS
THYRISTOR OR SILICON CONTROLLED RECTIFIER LOADING

REACTIVE LOAD CONTROL

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive load to the generator with the lower field current. This is known as the reactive circulating current and there are two methods of controlling it in parallel operation:

1. Reactive droop compensation. (Formerly known as parallel droop compensation.)

   The bus voltage droops, or decreases, as the reactive lagging power factor load is increased.

2. Reactive differential compensation. (Formerly known as cross current compensation.)

   The reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage. The RDC circuit must meet the following criteria:

   A. All paralleling current transformers for all the generators being paralleled must be included in the secondary interconnection loop.

   B. When different size generators are paralleled, all paralleling current transformers must have the same or proportional ratios that give approximately the same secondary current.

   C. Voltage regulator paralleling circuitry must be the same.

   D. Current transformer secondaries and the generator lines must be isolated electrically.

      Because of the above criteria, reactive differential compensation cannot be used when paralleling with the utility power grid. There is no limit, however, in the number of generators that can be included in this type of circuit.

   E. It is also desirable to have an auxiliary contact on the main generator breaker to short the parallel CT secondary when that breaker is open (not connected to the load buss).

PARALLELING CIRCUITRY

Because of the number of variables involved in paralleling generator sets, every installation will have its own circuitry and methods or procedures of bringing paralleled units on line. There are numerous ways of connecting paralleled units and an almost unlimited variety of applications and associated equipment.

When parallel operation is desired, it is important that the control manufacturer, the generator manufacturer and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

THYRISTOR OR SILICON CONTROLLED RECTIFIER LOADING

Solid state electronic control devices which utitize thyristors or SCR firing circuits (such as variable frequency induction motor controls, precision motor speed controls, no-break powered battery chargers, etc.) can introduce high frequency harmonics which adversely affect or distort the normal waveform of the generator. This creates additional heat in the generator stator and rotor, and can cause overheating. These devices can and do present problems to non-utility power generating equipment or any limited power buss system. The problems which can occur are not limited to the generator itself, but can effect the solid state control devices, the equipment it controls, other associated loads, monitoring devices or a number of combinations over the entire system.

Magna One generators can supply some thyristor and SCR loads when properly applied. For a single thyristor (SCR) load, the maximum KVA load on the generator should be limited to about 60% of the generator rating. Where thyristor (SCR) loading is less than 30% of the total loading, derating of the generator is not normally required. It is important that the control manufacturer, the generator manufacturer and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

OPERATION

PRE-START INSPECTION
STARTING-UP THE GENERATOR
FIELD FLASHING

PRE-START INSPECTION

Before operating the generator for the first time, the following checks are recommended.

1. Check all wiring against the proper connection diagrams and make sure all connections are properly insulated.
2. Inspect for any remaining packing materials and remove loose clothes and all tools.
3. Check that all covers and guards are installed and tight.

IDLING

Permanent equipment damage can be caused by idling the engine between 650 and 1400 generator rpm. If engine adjustments require idling at these speeds, the REGULATOR FUSES MUST BE REMOVED before engine start-up and adjustment.

WARNING

RESIDUAL VOLTAGE IS PRESENT AT THE GENERATOR LEADS AND AT THE REGULATOR PANEL CONNECTIONS, EVEN WITH THE REGULATOR FUSES REMOVED. CAUTION MUST BE OBSERVED OR SERIOUS PERSONAL INJURY OR DEATH CAN RESULT. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

If generator is supplied with the optional regulator power "off-on" switch, simply turn the switch to the "off" position; or if supplied with the optional underfrequency module, the regulator is protected. WHEN IN DOUBT, REMOVE THE FUSES. After engine adjustment, the regulator fuses should be replaced. The engine should be brought through the 650-1400 rpm range in less than 45 seconds.

VOLTAGE ADJUSTMENTS

A means for adjusting the voltage is incorporated in the regulator. For details refer to the Voltage Regulator Manual applicable to this unit.

STARTING-UP THE GENERATOR

The following procedure should be followed for starting-up the generator set:

1. The generator output must be disconnected from the load. Be certain that the main circuit breaker is open.
2. Start the prime mover and adjust it for the proper speed. If unit is not frequency protected, remove the fuses.
3. If fuses have been removed, replace the fuses and adjust the voltage to the required value by means of the voltage adjust rheostat.
4. Close the main circuit breaker and apply the load.
5. Adjust engine speed at full load to 1800 rpm for 60 hertz, 1500 rpm for 50 hertz.
6. Before stopping the engine, remove the load by tripping the main circuit breaker.

FIELD FLASHING

The generator relies on residual voltage to start the generator action which in turn produces the rated voltage. If the generator fails to produce a voltage after it has come up to rated speed, it may be necessary to flash the field. This procedure must be done while the generator is at a standstill. See the Field Flashing Procedure for further information.

FIELD FLASHING PROCEDURE

With the generator set shut down, apply a 12 volt dc flashing source (battery) across terminals F+ and F- on the voltage regulator. The positive terminal of the battery must be connected to F+ and the negative terminal to F-. CAUTION: If these leads are reversed, the voltage regulator will be destroyed. A diode in the voltage regulator allows the flashing source to be removed from the field without the danger of inductive arcing. This action remagnetizes the exciter field and allows build-up when the system is restarted.

OPERATION

PREVENTATIVE MAINTENANCE
CLEANING METHODS

PREVENTATIVE MAINTENANCE

Dirt and heat are common enemies of a generator. Keeping the generator clean, preventing overloads, and proper alignment of the generator and its prime mover will result in efficient operation.

Accumulations of dust and dirt not only contribute to insulation breakdown, but they can also increase temperature by restricting ventilation and by blocking the dissipation of heat from the winding and frame surfaces. Some machines are exposed to accumulations of materials such as talc, lint, or cement dust, which may obstruct the ventilation. The most harmful types of foreign materials include carbon black, metallic dust and chips, and similar substances which not only impede the ventilation, but also form a conductive film over the insulation, increasing the possibility of insulation failure. Machines operating in dirty places should be disassembled and cleaned periodically.

Dirt and dust will conduct electricity between points of different electrical potential. The regulator must be kept free of excessive amounts of dust and dirt. Low pressure, moisture-free compressed air may be used to blow out any dust and dirt.

CLEANING METHODS

When electrical components get dirty, the insulation must be cleaned. There are a number of acceptable methods for cleaning the generator, each of which will necessitate disassembly of the unit. The method of cleaning will be determined by the kind of dirt, and when the unit must be returned to service. Drying after cleaning is necessary.

Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should cover the condition of the windings and insulation, and the effectiveness of the supporting ties as evidenced by the rigidity of the coil end turns.

SOLVENTS

It is recommended that only petroleum distillates be used for cleaning electrical components.

A solvent is usually required to remove accumulated soil containing oil or grease. A wet rag with solvent is suitable for wiping.

Dry components thoroughly with moisture-free, low pressure compressed air.

CAUTION: CARE MUST BE TAKEN NOT TO GET SOLVENT ON INSULATING VARNISHES OR DETERIORATION OF VARNISH WILL OCCUR.

Petroleum solvents of the safety type should be used. The flash point of these solvents should be greater than 100° F (38° C).

WARNING

ADEQUATE VENTILATION MUST BE AVAILABLE TO AVOID FIRE, EXPLOSION AND HEALTH HAZARDS WHERE SOLVENTS ARE USED. AVOID BREATHING SOLVENT VAPORS. RUBBER GLOVES OR OTHER SUITABLE PROTECTION FOR THE HANDS SHOULD BE USED.

CLOTH AND COMPRESSED AIR

Cleaning with a dry cloth may be satisfactory when components are small, the surfaces are accessible and only dry dirt is to be removed.

Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places which cannot be reached with a cloth. Use clean dry air at 30 PSI (206 KPA).

BRUSHING AND VACUUM CLEANING

Dry dust and dirt may be removed by brushing with bristle brushes followed by vacuum cleaning. Do not use wire brushes. Vacuum cleaning is an effective and desirable method of removing dry and loose dirt.

SHELL BLASTING

Air blasting with ground nut shells may be satisfactory for removal of hand dirt deposits from insulation. Use mild abrasives such as 12-20 mesh ground walnut shells.

DRYING ELECTRICAL INSULATION

Electrical components, after cleaning, storing or shipping must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value. See approved drying procedures in the "Installation Section" of the manual.

DRYING ELECTRICAL INSULATION

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AIR INTAKE AND EXHAUST

Check the area around the air intake and exhaust openings to be sure they are clean and unobstructed. Remove all foreign material and clean all screens.

ELECTRICAL CONNECTIONS AND WINDINGS

Inspect for loose or contaminated connections. Check wires for cracked or frayed insulation. Tighten connections and replace defective or oil soaked insulation.

If inspection shows that varnish coatings on the windings have deteriorated, they should be recoated with insulating varnish. Please refer to Marathon Electric for insulation system requirements.

LUBRICATION

All generators are lubricated before leaving the factory and are ready for operation. As a general rule, bearings should be relubricated annually or at the indicated intervals in table 1, whichever occurs first. Unusually severe operating conditions, such as high ambient or dusty environments, require more frequent lubrication (every six months or one half the table intervals, whichever occurs first). 360 Frame generators are premanently lubricated, and therefore regreasing is not necessary.

Use Cheveron SRI #2 or equivalent anti-friction type, high quality, grease with a lubrication temperature range of lowest ambient temperature expected to +260°F.

During an overhaul, the grease reservoir should be thoroughly cleaned and new grease added. The reservoir should be 1/3 to 1/2 filled with new grease.

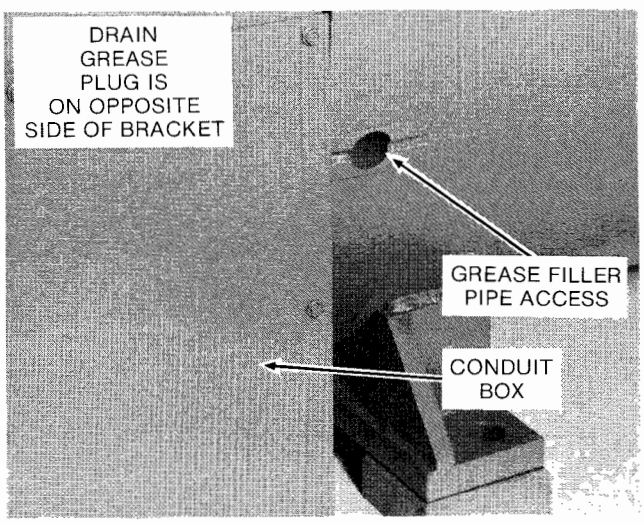
To add or renew grease, proceed as follows:

1. Stop unit.
2. Wipe clean the grease plugs and surrounding parts.
3. Remove filler and drain plugs (see figure to right).
4. Insert 1/8" N.P.T. grease fitting or appropriate fitting in filler pipe.
5. Free drain hole of any hard grease, using a piece of wire if necessary.
6. Using a low pressure grease gun, add grease according to the amounts in table 1.
7. Start unit with drain plug removed - filler pipe may be open or closed. Allow unit to run 15 minutes to allow excess grease to drain.
8. Stop unit, wipe off any drained grease, and replace filler and drain plugs.

CAUTION: USE ONLY CLEAN GREASE FROM CLEAN, CLOSED CONTAINERS AND KEEP IT FROM BEING CONTAMINATED WHILE REGREASING.

The amount of grease added is very important! Only enough grease should be added to replace the grease used by the bearing.

CAUTION: TOO MUCH GREASE CAN BE AS HARMFUL AS INSUFFICIENT GREASE - USE THE PROPER AMOUNT.



OPERATION

LUBRICATION

TABLE 1: RELUBRICATION AMOUNTS AND INTERVALS

	FRAME SIZE	BEARING SIZE	AMOUNT OF GREASE			INTERVALS①	
			OUNCES	CUBIC INCHES	TEASPOONS	60 HZ	50 HZ
SINGLE BEARING UNITS	440	312	1.0	1.8	5.8	7600	8800
	500, 502	314	1.2	2.1	7.0	6500	8400
	680, 682, 683	320	2.1	3.7	12.2	3800	5300
DOUBLE BEARING UNITS (SHAFT END BEARING ONLY)	440	318	1.7	3.0	9.9	4600	6200
	500, 502	318	1.7	3.0	9.9	4600	6200
	680, 682, 683	322	2.4	4.2	14.0	3000	4500

①HOURS OF RUNNING TIME

SERVICE

DISASSEMBLY

REMOVAL FROM PRIME MOVER

WARNING

DISCONNECT ALL POWER BEFORE SERVICING. FAILURE TO FOLLOW ALL SAFETY INSTRUCTIONS CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

1. Remove louvered conduit box cover. (See Figure 1).

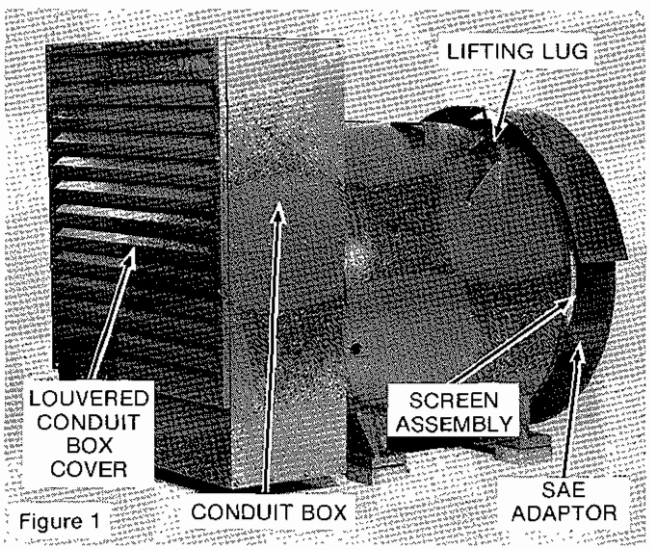


Figure 1

2. Disconnect all electrical load leads from the generator leads (or buss bars) inside the conduit box.
3. Remove all conduit or ducting from the conduit box.
4. Attach a suitable hoist to the generator lifting lugs.
5. a. For two-bearing generators, disconnect the coupling or sheave and belts between the generator and prime mover. (Follow the coupling manufacturer's instructions for disconnection.)

   b. For single bearing generators, remove the bolts mounting the screen assembly to the SAE adaptor and remove the screen. (See Figure 2.) (NOTE: Do not remove the dripcover from the screen assembly if so equipped.) Remove the capscrews attaching the drive discs to the flywheel and remove the capscrews attaching the SAE adaptor to the flywheel housing.

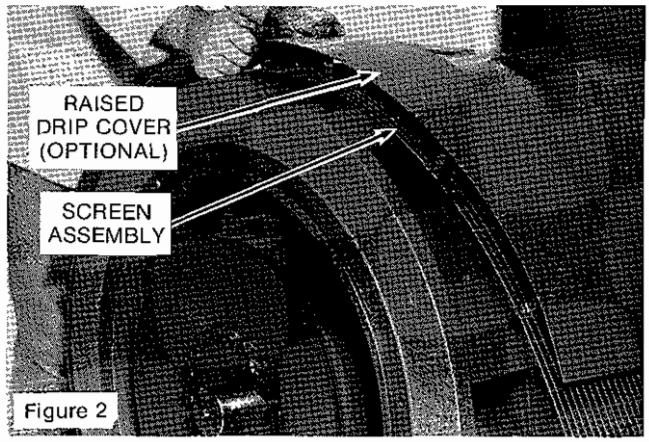


Figure 2

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

6. Remove the mounting bolts which secure the generator to the base.
7. Raise the generator slightly and move the generator away from the prime mover.
8. On single bearing generators, if generator is to be shipped, see Shipping Instructions Section for proper rotor support.

EXCITER REMOVAL

1. Remove regulator enclosure and disconnect F1 and F2 leads from the corresponding F+ and F− terminals on the terminal block on the regulator panel. (See Figure 3).

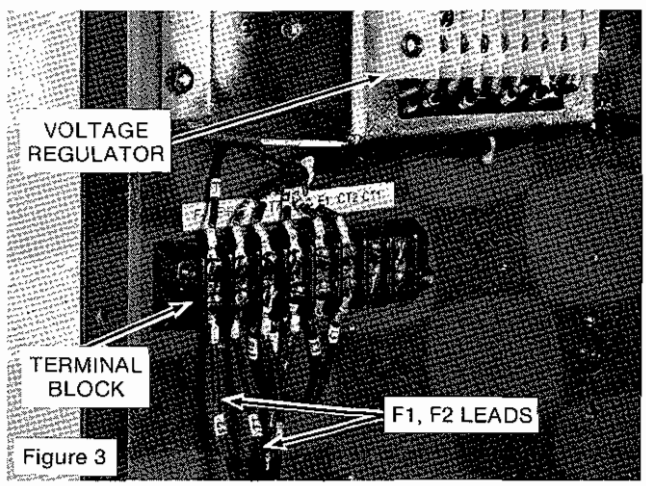


Figure 3

SERVICE

DISASSEMBLY

2. Remove all lead fasteners connecting F1 and F2 leads to the front end bracket or conduit box. Remove the four capscrews and belleville washers holding the exciter stator and lead shield in place. (See Figure 4.) Remove the lead shield. Mark the exciter stator "top front" for reference. (See Figure 5.) Remove the exciter stator.

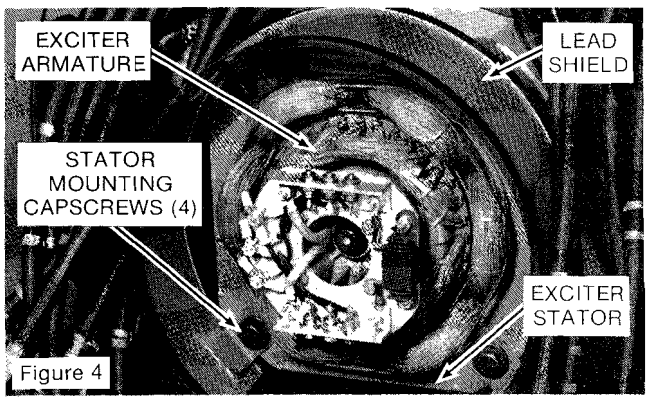


Figure 4

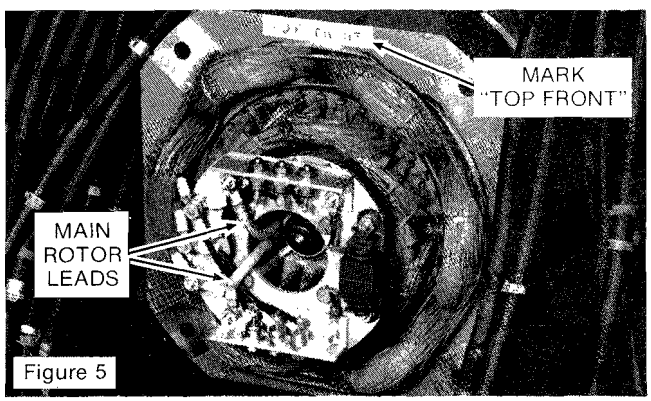


Figure 5

3. Disconnect both main rotor leads coming out of the aluminum standoff plate lead hole from the rectifier aluminum angle. (See Figure 6.)

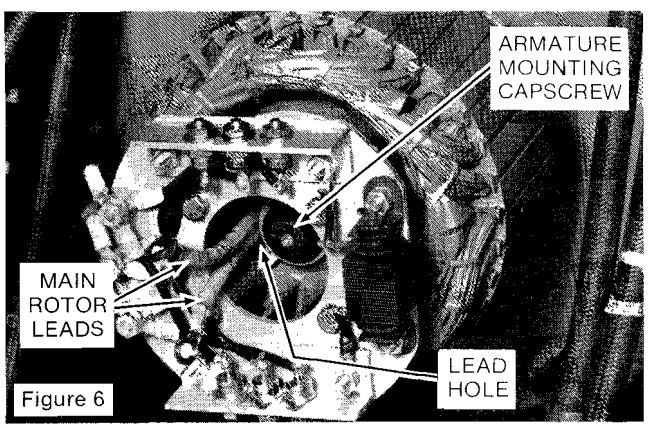


Figure 6

4. Remove the capscrew and belleville washer which holds the exciter (rotor) armature to the generator shaft. Use a six inch, 3/4 - 16NF capscrew threaded into the aluminum standoff plate to push against the end of the shaft. (See Figure 7.) Carefully feed the leads through the lead hole in the aluminum standoff plate as the armature is removed.

CAUTION: DO NOT TIGHTEN THE ARMATURE REMOVAL CAPSCREW BEYOND THE END OF THE THREADS. IF THE THREAD LENGTH IS NOT SUFFIFICIENT TO REMOVE THE EXCITER ARMATURE, USE A PIECE OF THREADED ROD WITH A NUT WELDED ON THE END.

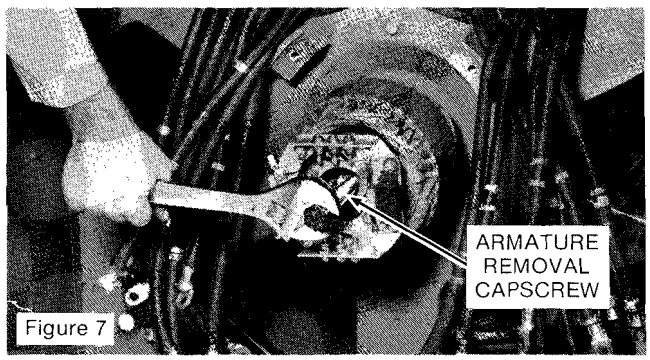


Figure 7

MAIN ROTOR REMOVAL

1. a. For two bearing generators, remove the two capscrews and lockwashers holding the bearing lock to the drive end bracket. On 680, 682 Frame generators, remove the two capscrews holding the bearing cap to the front end bracket. (See Figure 8.)

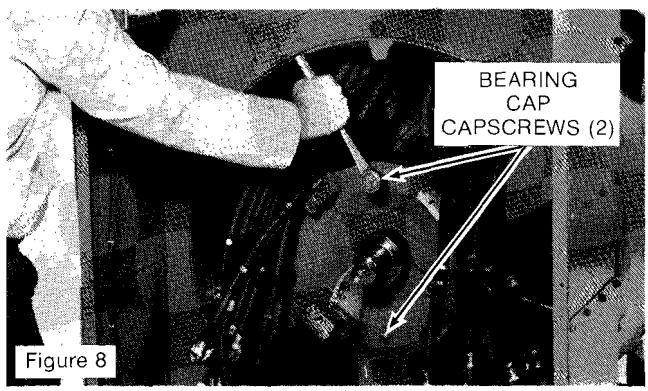


Figure 8

b. For single bearing 680, 682 Frame generators, remove the two capscrews holding the bearing cap to the front end bracket. (See Figure 8.)

2. If the screen assembly is still mounted, remove the bolts securing the screen assembly to the drive end bracket or the SAE adaptor and remove the screen assembly. (See Figure 9.) (NOTE: Do not remove the drip cover from the screen assembly if so equipped.)

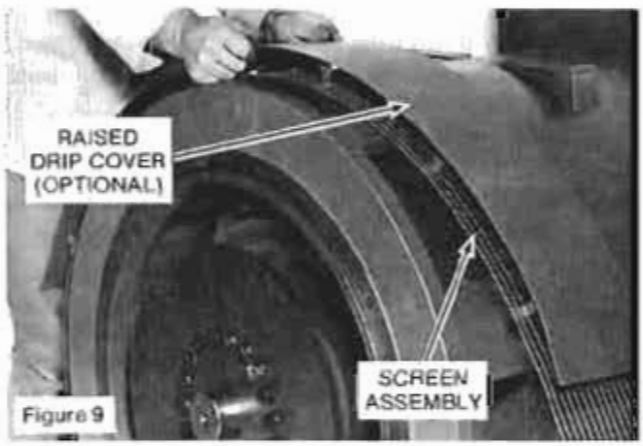


Figure 9

3. a. For two bearing generators, remove the drive coupling half or sheave from the shaft extension.

b. For single bearing generators, remove the capscrews and hardened washers holding the drive discs to the drive hub. (See Figure 10.) (NOTE: Capscrew removal can most easily be accomplished by starting at the bottom and removing the capscrews in a clockwise sequence.) Remove all drive discs (and spacers if any).

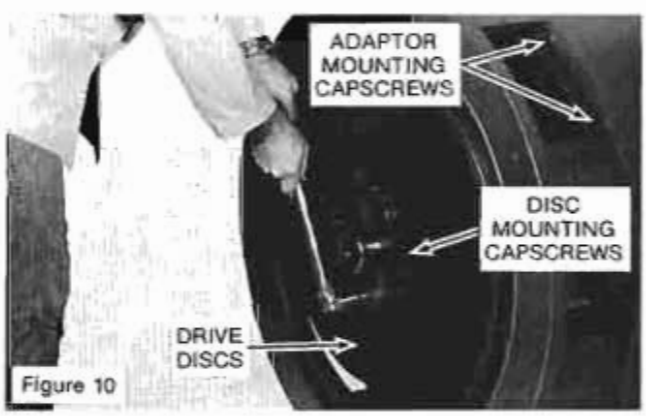


Figure 10

4. a. For two bearing generators, remove the capscrews holding the drive end bracket to the generator and remove the bracket.

b. For single bearing generators, remove the capscrews holding the SAE adaptor to the generator and remove the adaptor. (See Figure 11.)

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN DRIVE END BRACKET OR SAE ADAPTOR REMOVAL.

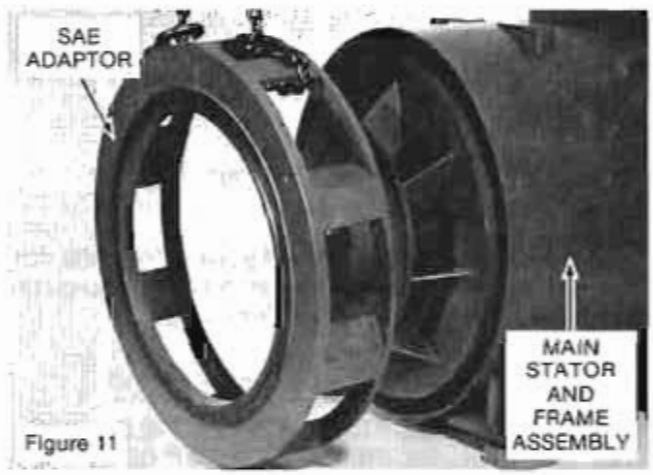


Figure 11

5. Using a rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly from the main stator and frame assembly through the drive end. (See Figure 12.)

CAUTION: SPECIAL CARE SHOULD BE USED IN THE ROTOR ASSEMBLY REMOVAL, OR WINDING DAMAGE COULD RESULT.

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

SERVICE

DISASSEMBLY

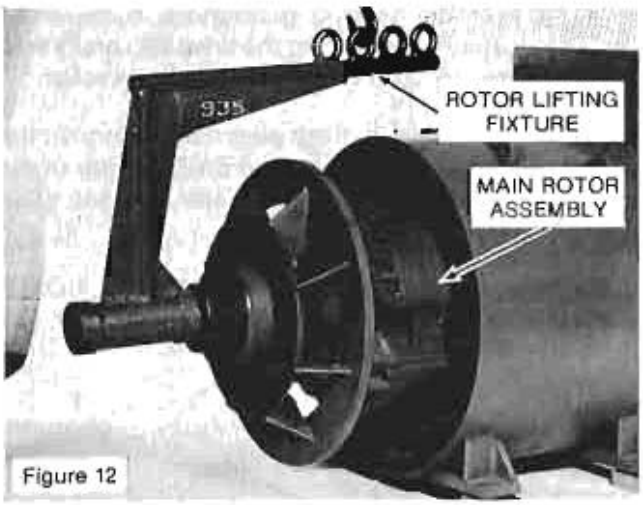


Figure 12

CONDUIT BOX AND FRONT END BRACKET REMOVAL

1. Disconnect the following leads from the corresponding points on the terminal strip on the regulator panel: (See Figure 13.)

Frame Size	Leads to be Disconnected
360, 440, 500	T0, T7, E3, [CT-1, CT-2 if used]
502, 680	T7, T9, [CT-1, CT-2 if used]
682	T0, T7 E1, E3, [CT-1, CT-2 if used]

NOTE: The above lead combinations are used on the standard generators; other leads may have to be removed depending on the particular application.

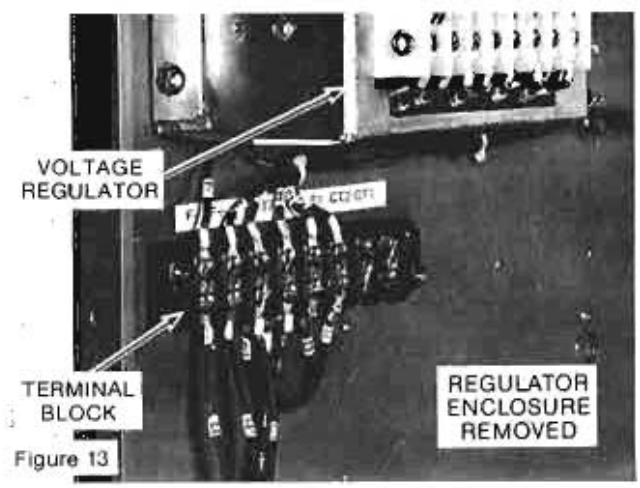


Figure 13

2. On generators with buss bars, disconnect all main stator leads bolted to the buss bar assembly, making sure all leads are marked for identification before removal. (See Figure 14.)

3. a. On generators with four buss bars (T1, T2, T3, T0), remove the capscrew, flat washer and lockwasher mounting the red insulating channel to the front end bracket. Remove the buss bar support mounting capscrews and lockwashers. Remove the buss bar assembly. Remove the capscrews and lockwashers mounting the neutral buss bar to the support.

   b. On generators with six buss bars (T1, T2, T3, T4, T5, T6), remove the capscrews and lockwashers mounting the buss bar support to the front end bracket. Remove the buss bar assembly (T1, T2 and T3). The neutral buss bar assembly (T4, T5 and T6) can remain in the bottom of the conduit box.

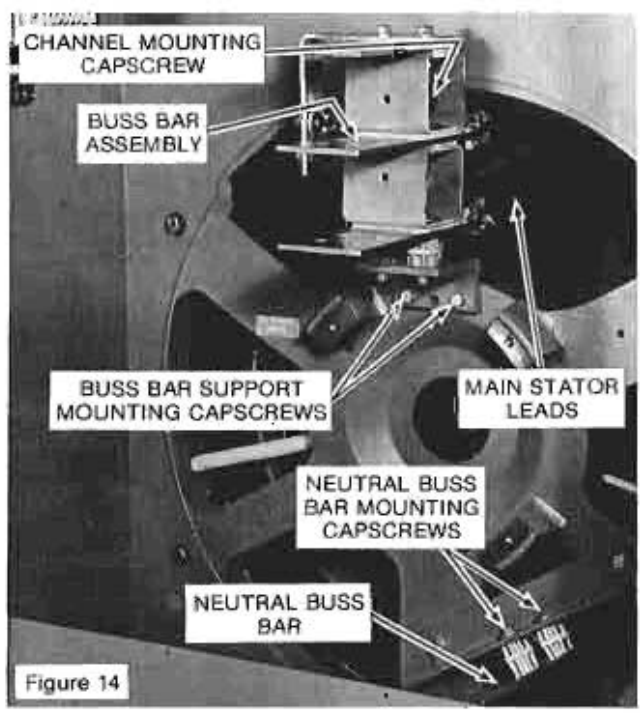


Figure 14

4. Remove the capscrews and starwashers holding the conduit box and front end bracket to the main stator assembly. (See Figure 15.) Lift off the conduit box.

5. On 680, 682 Frame generators, remove the one additional mounting capscrew at the bottom of the front end bracket. (See Figure 16.)

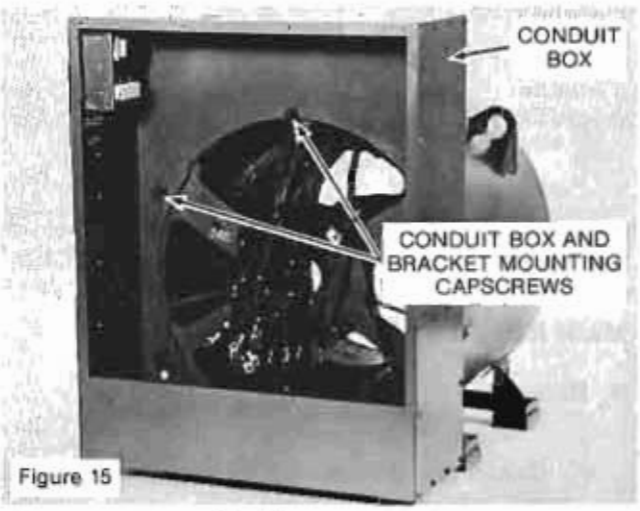


Figure 15

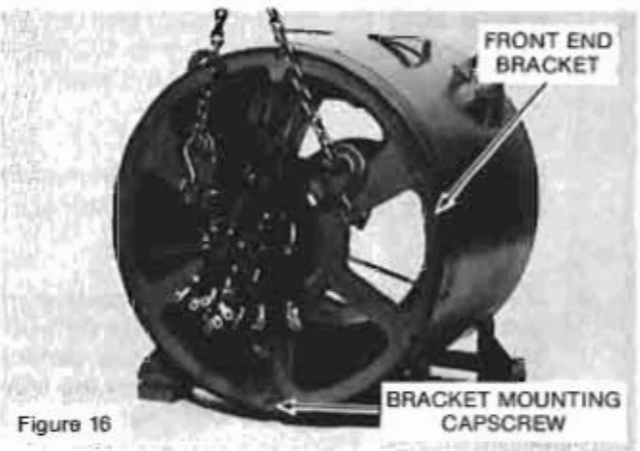


Figure 16

6. Remove the front end bracket from the main stator assembly. (See Figure 17.)

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET REMOVAL.

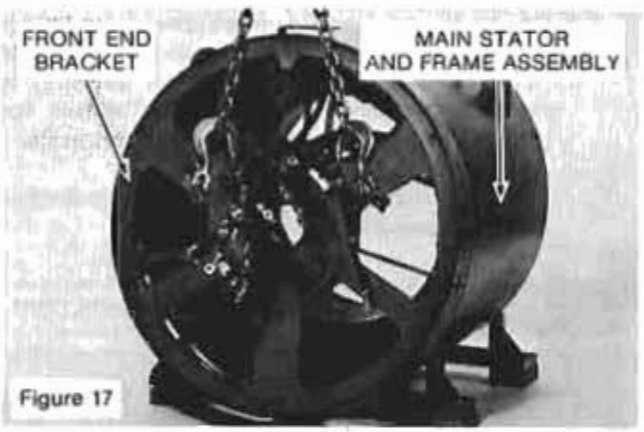


Figure 17

SERVICE

INSPECTION

EXCITER INSPECTION

A. Exciter Stator

1. Clean dust and dirt from the stator winding with a soft cloth or brush. (See Figure 18.) (See cleaning methods under Preventative Maintenance.)

2. Check the exciter stator winding for a loose, frayed, or burnt winding. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.

3. Look for score marks in the bore of the exciter core caused by rubbing.

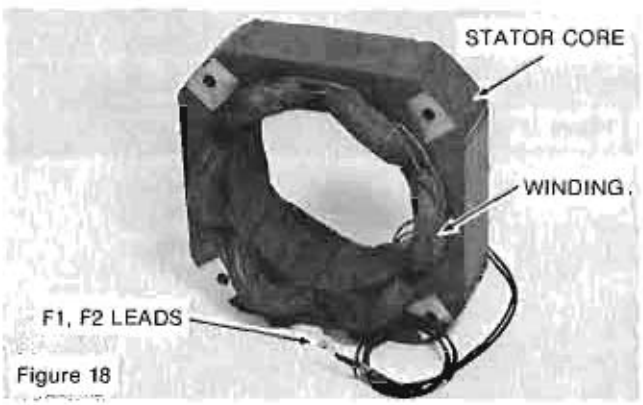


Figure 18

B. Exciter (Rotor) Armature

1. Clean all metal parts with an approved cleaning solvent.

2. Clean dust and dirt from the exciter armature and rectifier assembly with a soft cloth or brush. (See Figure 19.) (See cleaning methods.)

3. Check the exciter armature for burrs on the mating surfaces.

4. Check the rectifiers and surge protector for proper operation. (See Troubleshooting Section.) Replace defective parts.

5. Check the exciter armature and rectifier assembly for a loose, frayed, or burnt winding or loose connections. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.

6. Look for score marks on the outside diameter of the armature core caused by rubbing.

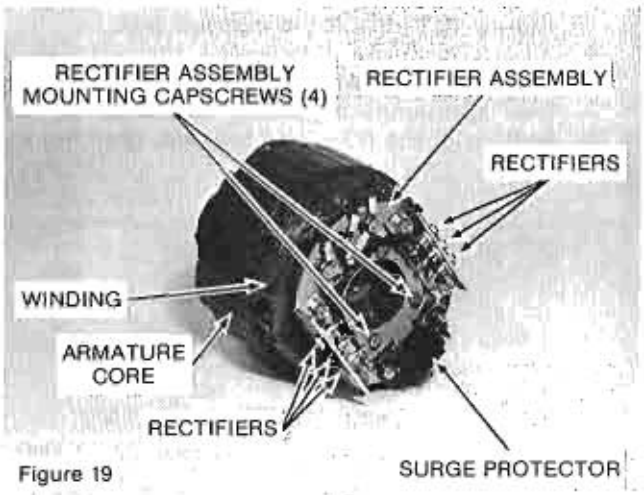


Figure 19

MAIN ROTOR INSPECTION

A. Bearing

1. Check the bearing for damage or wear. On 680-684 Frame generators, clean the old grease from the bearing cap, and fill the bearing cap grease cavity 1/3 to 1/2 full of new multipurpose lithium based grease.

NOTE: If the bearing needs to be removed, for any reason, always install a new bearing.

2. If the bearing is to be replaced, remove with a suitable puller. (See Figure 20.) On 680-684 Frame generators and two bearing generators, be sure the bearing cap is on the shaft before installing the new bearing.

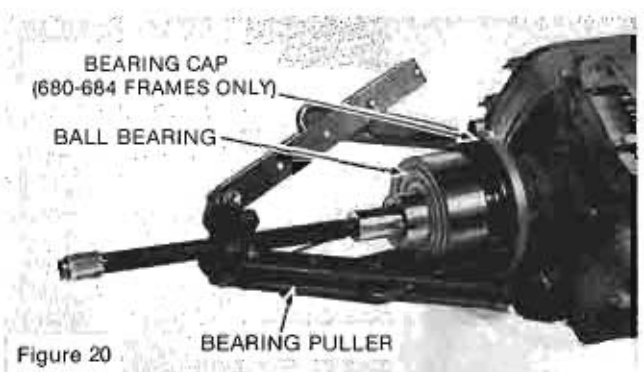


Figure 20

Heat the new bearing in an oven to a maximum temperature of 212° F (100° C). Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using asbestos gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. (See Figure 21.) The bearing should slide on the shaft and be seated without excessive force. If the bearing binds on the shaft before being fully seated, a piece of tubing, slightly larger than the press-fit area, can be used to drive the bearing into place. Using light taps with a soft mallet, apply pressure to the inner race only.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD PRESSURE BE APPLIED TO THE OUTER RACE OF THE BEARING, AS PERMANENT BEARING DAMAGE COULD RESULT.

Allow the bearing to cool for one hour before attempting to assemble the generator.

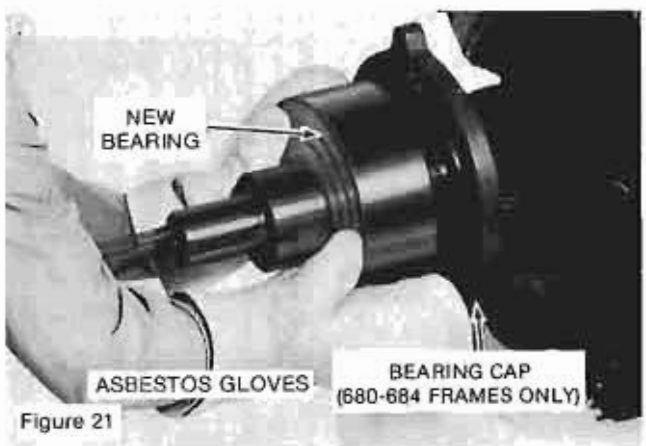


Figure 21

B. Drive Hub (Single Bearing Generators Only)

1. Check the drive hub for cracks or stripped drive disc mounting holes. Replace the hub if defective.

2. If the hub is to be replaced, mark the fan and hub for alignment to ensure proper balance after reassembly. Remove the fan mounting capscrews and belleville washers and move the fan back away from hub. (See Figure 22.) Install a suitable puller to the hub. Remove the setscrew in the hub over the key. Using a torch, rapidly heat the hub at the outer diameter while tightening the puller. (This must be done rapidly before the heat can expand the shaft.) Remove the hub. (Check the fan for defects according to Section C.)

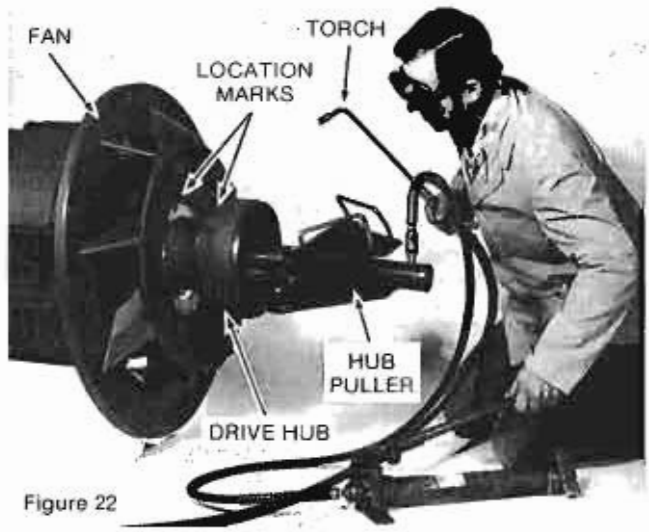


Figure 22

Mark the new hub in the same place as the old hub relative to the keyway. Heat the new hub in an oven to 500° -600° F (260° -316° C). Be sure that the fan is still on the shaft. Using asbestos gloves, slide the hub over the key in the shaft until it seats against the shaft shoulder. (See Figure 23.)

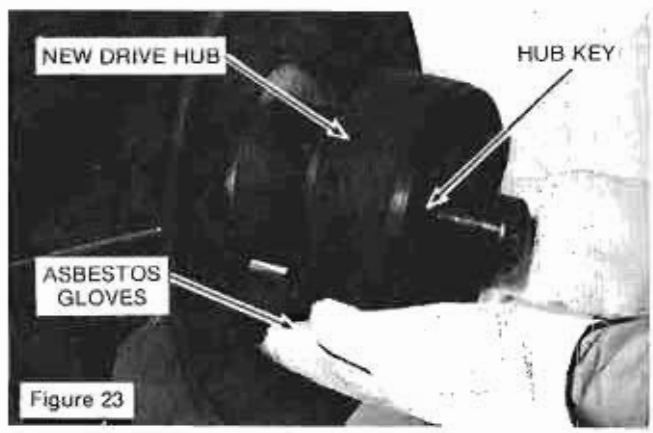


Figure 23

Allow the hub to cool for one hour. After the hub has cooled, tighten the setscrew in the hub to 50 ft-lbs (68 N.m) torque. Match the alignment marks on the fan and hub and mount the fan with the capscrews and belleville washers. (See Figure 24.) Torque the capscrews per Figure 49. (See Figure 25.)

SERVICE

INSPECTION

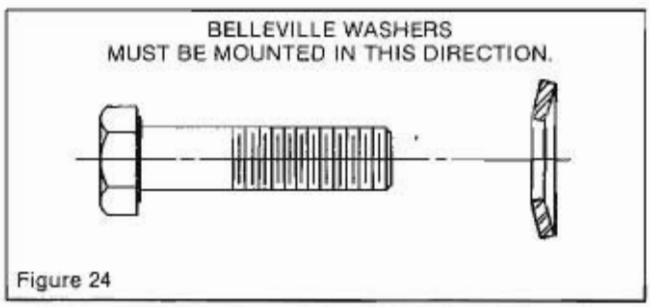


Figure 24

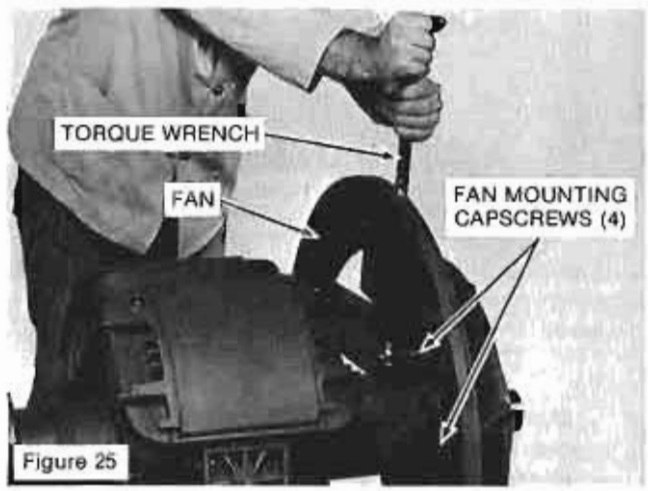


Figure 25

Rebalancing of the rotor assembly is not necessary if only the hub is replaced and the fan is mounted in the same location relative to the hub.

C. Fan

1. Check the fan for cracks or broken blades. Replace the fan if defective.

2. a. For two-bearing generators, remove the drive end bearing cap. (See bearing removal instructions above.) Remove the fan setscrews. Using a torch, rapidly heat the backside of the fan.

CAUTION: DO NOT HEAT THE FAN ABOVE 400-500° F (204-260° C) AS THIS WILL REMOVE THE TEMPER FROM THE FAN.

Using asbestos gloves, slide the fan off the shaft. Heat the new fan in an oven to 400° - 500° F (204° -260° C). Using asbestos gloves, slide the fan over the key in the shaft until it seats against the shaft shoulder. Allow the fan to cool for one-half hour. After the fan has cooled, tighten the setscrews in the fan to 17 ft-lbs (23 N.m) torque. Install the bearing cap and a new bearing according to the bearing assembly instructions above.

b. For single bearing generators, remove the hub according to the above drive hub removal instructions. Slide the fan off the shaft. Slide the new fan on the shaft making sure the fan mounting surface is toward the drive hub. Mount the hub according to the drive hub assembly instructions above. Mount the fan to the drive hub with the capscrews and belleville washers (see Figure 24). Torque the capscrews per Figure 49. (See Figure 25.)

3. The rotor assembly must be rebalanced if a new fan has been installed.

D. Main Rotor Core and Windings

1. Clean all metal parts with an approved cleaning solvent. Remove dust and dirt from the rotor windings with a soft cloth or brush. (See Figure 26.) (See cleaning methods.)

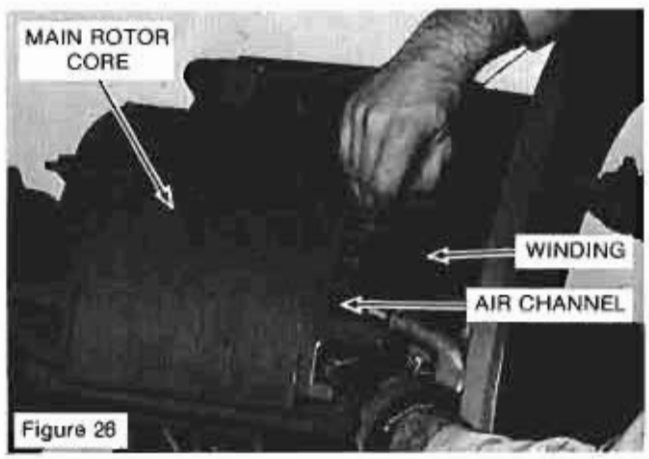


Figure 26

Remove any accumulated dust or dirt in the winding air channels with a piece of wire or with low-pressure, moisture-free air.

CAUTION: IF A PIECE OF WIRE IS USED FOR CLEANING THE AIR CHANNELS; CARE MUST BE TAKEN NOT TO SCRATCH THE WINDING AS THIS COULD CAUSE AN INSULATION FAILURE.

2. Check the rotor for loose, frayed, or burnt windings. A defective rotor winding must be rewound by Marathon Electric. The rotor assembly must be rebalanced after any rework or repair has been completed.

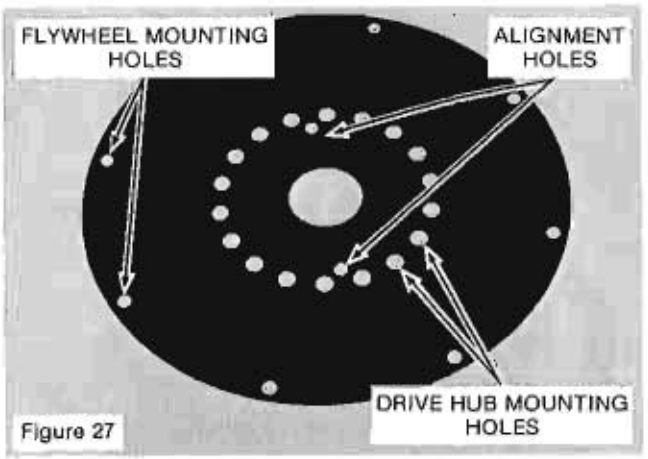


Figure 27

F. Drive Discs (Single Bearing Generators Only)

1. Inspect the drive discs for distorted or bent edges. (See Figure 27.) Inspect for worn mounting holes. Replace all defective discs as necessary.

2. Inspect the drive disc mounting capscrews for damaged threads. Replace capscrews if damaged.

FRONT END BRACKET INSPECTION

1. Remove the filler and drain grease pipes and the grease plugs from the bracket. (See Figure 28.)

2. Clean the end bracket, grease pipes, and capscrews in an approved solvent to remove all dust, dirt, and grease. Dry the parts thoroughly with compressed air.

3. Inspect the capscrews for stripped threads and replace if defective.

4. Inspect the end bracket for cracks and burred or rough mating surfaces. Inspect the bearing bore for burrs or wear. If the bracket shows excessive bearing bore wear, it should be replaced.

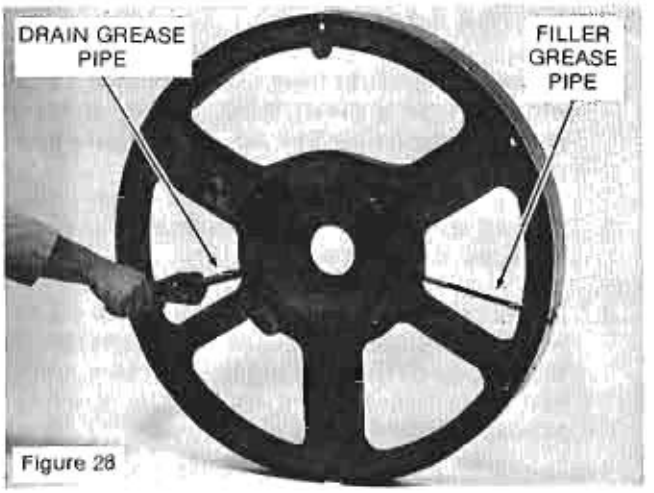


Figure 28

DRIVE END BRACKET OR SAE ADAPTOR INSPECTION

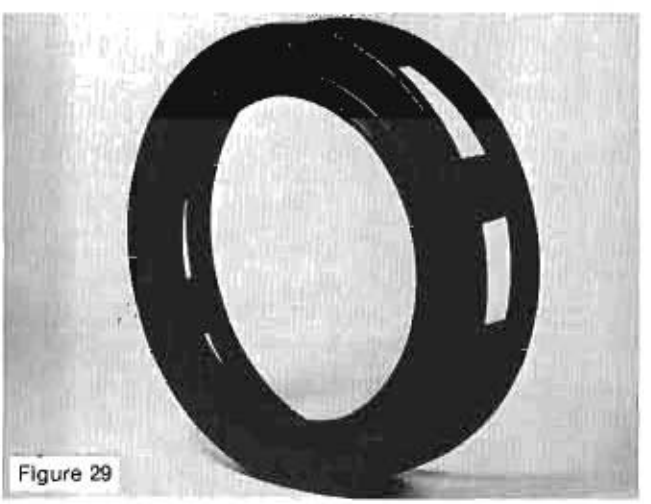
1. For two-bearing generators, remove the grease plugs from the bracket.

2. Clean the bracket or adaptor, capscrews and screen assembly in an approved solvent to remove all dust, dirt, and grease. (See Figure 29.) Dry the parts thoroughly with compressed air.

3. Inspect the capscrews for stripped threads and replace if defective.

4. Inspect the bracket or adaptor for cracks and burred or rough mating surfaces.

5. For two-bearing generators, inspect the bearing bore for burrs or wear. If the drive end bracket shows excessive bearing bore wear, it should be replaced.


Figure 29

SERVICE

INSPECTION

MAIN STATOR INSPECTION

1. Clean dust and dirt from the stator frame and winding with a clean cloth, brush, or low-pressure, moisture-free air. (See Figure 30.) (See cleaning methods.)

2. Inspect the frame for cracks, burred mating surfaces, or other damage.

3. Inspect the stator for a loose, frayed, or burnt winding. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.

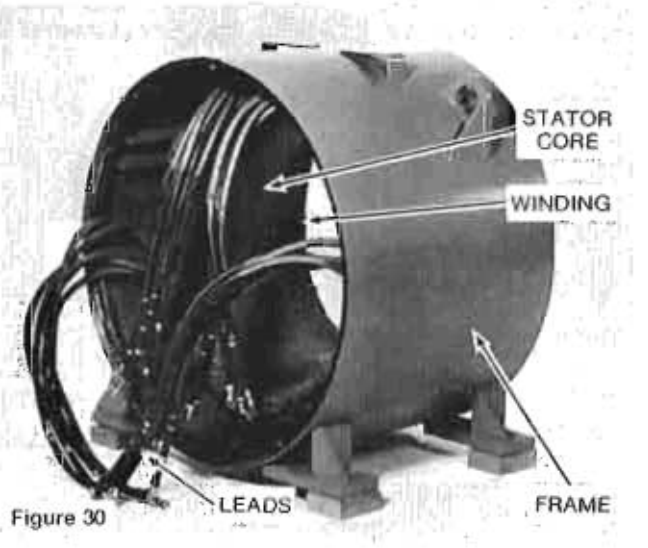


Figure 30

CONDUIT BOX AND VOLTAGE REGULATOR INSPECTION

1. Clean dust from the conduit box and the louvered cover with a clean cloth, brush, or low-pressure, moisture-free air. (See cleaning methods.)

2. Clean dust and dirt from the voltage regulator with a clean cloth, brush, or low-pressure, moisture-free air. (See cleaning methods.) Check all electrical connections for loose or broken wires.

CONDUIT BOX AND FRONT END BRACKET INSTALLATION

1. Fill the grease cavity of the front end bracket 1/3 to 1/2 full of new multipurpose lithium based grease. See "Lubrication Instructions" in this manual. Assemble all grease pipes and plugs in the bracket.
2. Install two guide pins in the main stator assembly frame. Align the bracket mounting holes to the guide pins and slide the bracket over the pins. (See Figure 31.) On 680, 682 Frame generators, install the bottom capscrew. (See Figure 32.)

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE FRONT END BRACKET INSTALLATION.

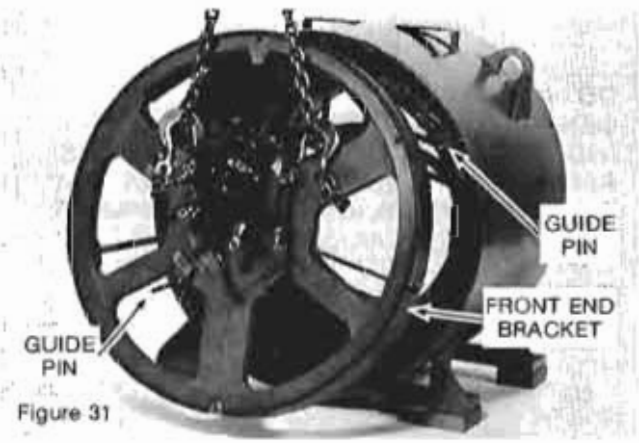


Figure 31

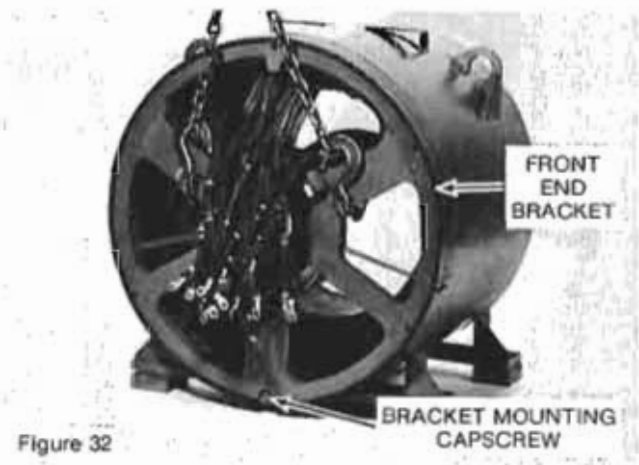


Figure 32

3. Insert two capscrews and starwashers through the conduit box and mount the conduit box to the bracket and main stator and frame assembly. (See Figure 33.) Remove the two guide pins and insert the remaining capscrews and starwashers.

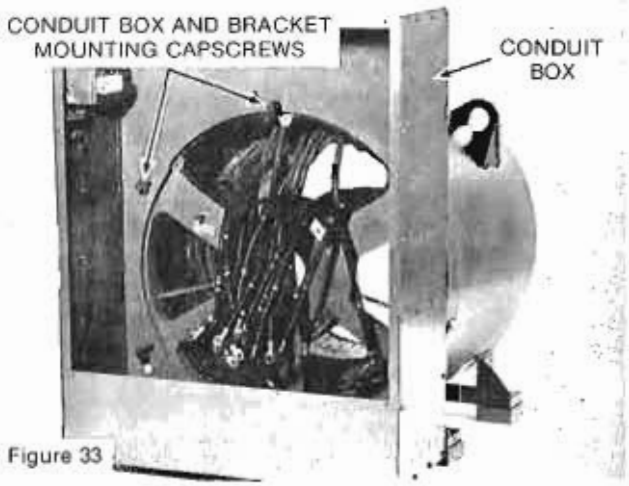


Figure 33

4. a. On generators with four buss bars (T1, T2, T3, T0), mount the neutral buss bar to the support with the capscrews and lockwashers. (See Figure 34.) Mount the buss bar assembly to the front end bracket with the capscrews and lockwashers. Assemble the capscrew, flat washer, and lockwasher through the red insulating channel into the front end bracket.

   b. On generators with six buss bars (T1, T2, T3, T4, T5, T6), mount the buss bar assembly support to the front end bracket with the capscrews and lockwashers.

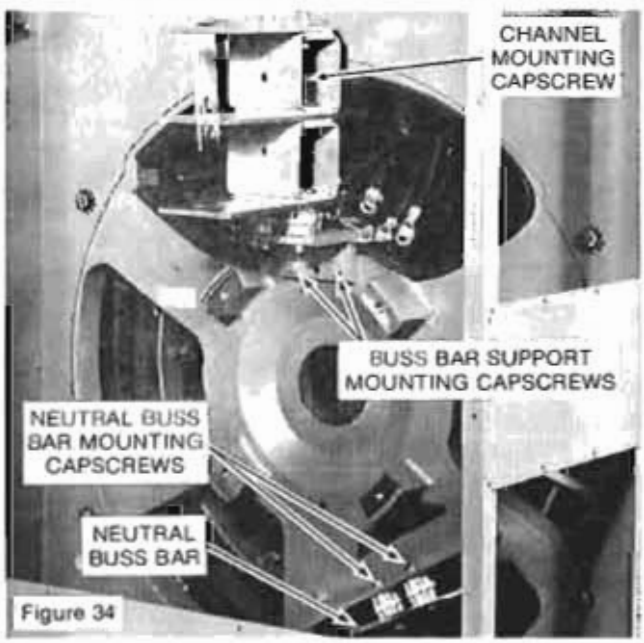


Figure 34

SERVICE

ASSEMBLY

5. On generators with buss bars, connect the main stator leads to the appropriate buss bar according to the lead markings. Insert a flat washer on the bolt, then assemble one terminal to the buss bar with the bolt and flat washer. (See Figure 35.) Insert a second lead on the bolt on the other side of the buss bar, then a flat washer, lockwasher, and locknut.

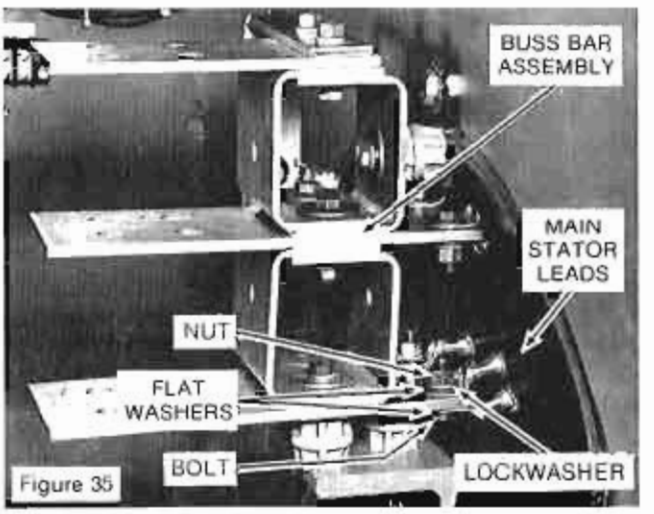


Figure 35

6. Connect the following leads to the corresponding points on the terminal strip on the regulator panel: (See Figure 36).

Frame Size	Leads to be Connected
360, 440, 500	T0, T7, E3, [CT-1, CT-2 if used]
502, 680	T7, T9, [CT-1, CT-2 if used]
682	T0, T7, E1, E3, [CT-1, CT-2 if used]

7. Install regulator enclosure.

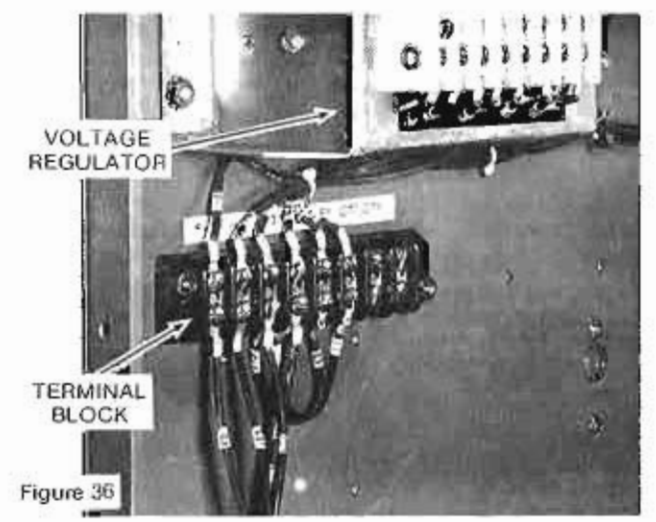


Figure 36

NOTE: These lead combinations are used on the standard generator; other leads may have to be reconnected depending on the particular application.

MAIN ROTOR INSTALLATION

1. Using a rotor lifting fixture and a suitable hoist, carefully install the rotor assembly into the main stator assembly through the drive end. (See Figure 37.) Carefully feed the rotor leads through the front end bracket shaft hole as the rotor is installed.

CAUTION: SPECIAL CARE SHOULD BE USED IN THE ROTOR ASSEMBLY INSTALLATION, OR WINDING DAMAGE COULD RESULT.

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

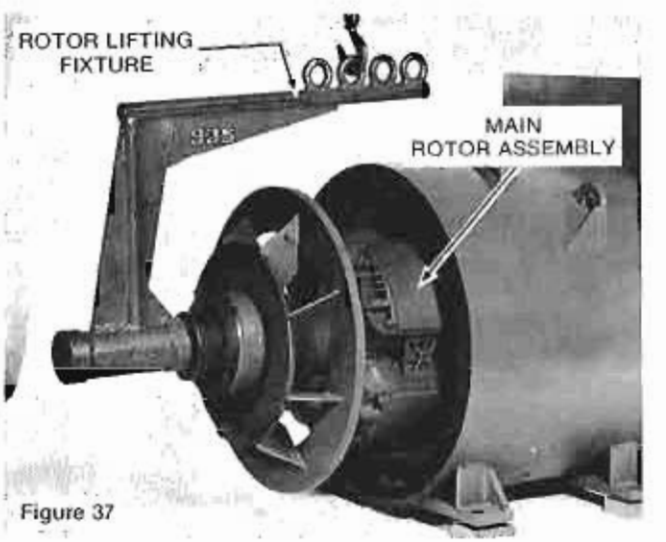


Figure 37

2. a. For two bearing generators, insert guide pins in the rear bearing lock holes. Fill the grease cavity of the drive end bracket 1/3 to 1/2 full of new miltipurpose lithium based grease. Assemble all grease plugs in the bracket. Mount the bracket on the bearing and guide the bearing lock pins through the bracket holes. Align the drive end bracket and mount with the capscrews. Remove one bearing lock guide pin and insert a capscrew and lockwasher into the bearing lock and tighten. Remove the remaining guide pin and replace with the remaining capscrew and lockwasher.

   b. For single bearing generators, pilot the SAE adaptor to the fan and secure to the main stator and frame assembly with capscrews torqued per Figure 49. (See Figure 38.) It may be necessary to raise the rotor assembly slightly to allow the mounting of the SAE adaptor.

CAUTION: ON LARGE GENERATORS, A HOIST AND LIFTING STRAP SHOULD BE USED TO ASSIST IN THE DRIVE END BRACKET OR THE SAE ADAPTOR ASSEMBLY.

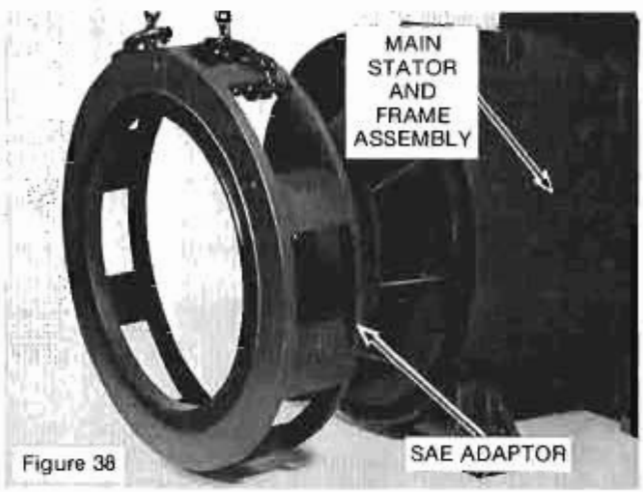


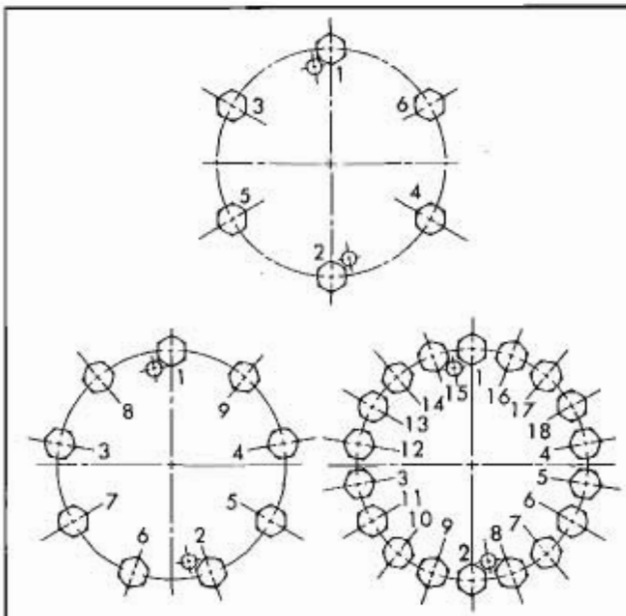
Figure 38

3. a. For two-bearing generators, install the drive coupling half or sheave on the shaft extension.

   b. For single bearing generators, insert a guide stud into the drive hub. Position all spacers (if any), then all drive discs, one at a time until all discs are installed. (See Figure 39.) Make sure that all disc mounting holes at the inner and outer diameter are properly aligned. Secure the discs with the capscrews and hardened washers torqued per Figure 49. (See Figure 40 for torquing sequence.)



Figure 39



Torque the bolts in the above sequence according to the correct bolt pattern.

Then check the torque in each bolt in a clockwise direction around the bolt circle to insure that all the bolts are properly torqued.

Figure 40

SERVICE

ASSEMBLY

4. Mount the screen assembly on the drive end bracket or the SAE adaptor and tighten the bolts. (See Figure 41.)

5. On 680, 682 Frame generators, insert the two capscrews and lockwashers into the front end bracket and secure the bearing cap. (See Figure 42.)

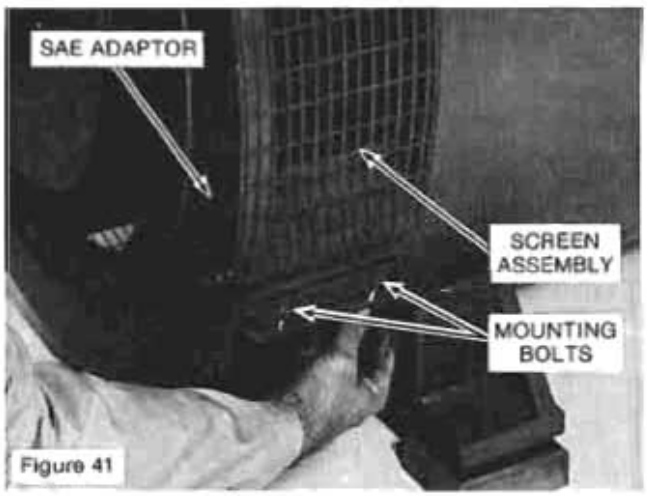


Figure 41



Figure 42

EXCITER INSTALLATION

1. Install the exciter key in the armature bore keyway. Attach a wire to the main rotor leads and feed the wire through the armature bore and out the lead hole in the aluminum standoff plate. Mount the armature on the end of the shaft and align the key in the armature bore to the keyway in the shaft. Slide the armature on the shaft while feeding the main rotor leads through the lead hole in the aluminum standoff plate. (See Figure 43.)

   Insert the capscrew and belleville washer (see Figure 44) through the mounting hole in the aluminum standoff plate and secure to the shaft (see Figure 45). Tighten the capscrew until the armature seats on the shaft. Torque the capscrew per Figure 49.

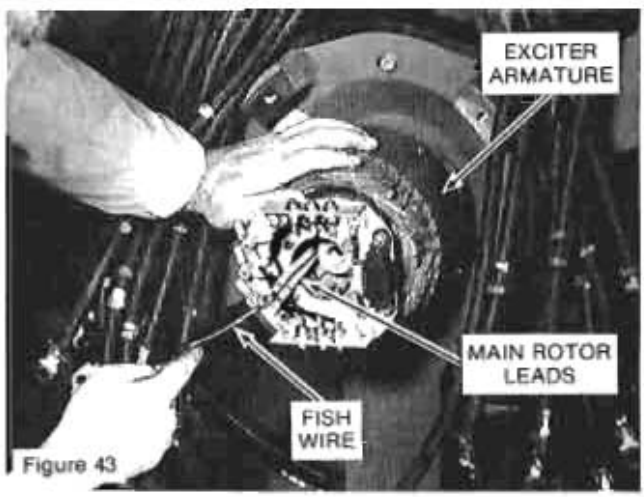


Figure 43

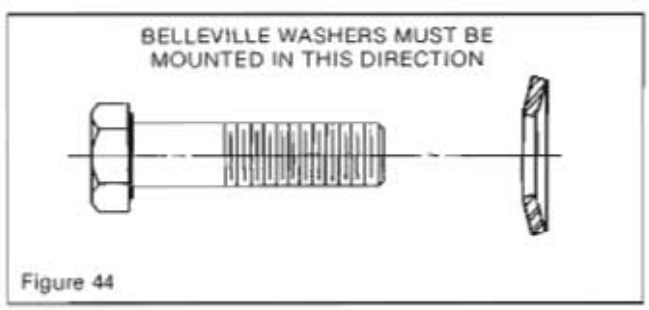


Figure 44

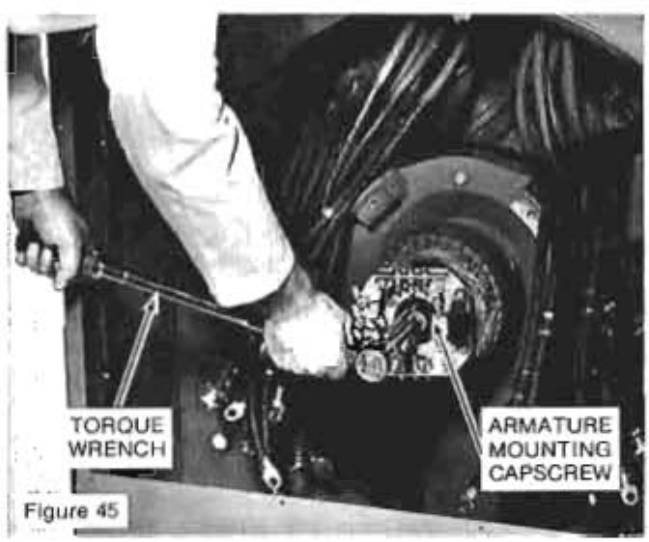


Figure 45

2. Connect both main rotor leads coming out of the aluminum standoff plate to the rectifier aluminum angle; one to each angle. (See Figure 46.)

3. Mount the exciter stator on the front end bracket mounting pads and align the mounting holes, noting the position of "top front" previously marked for reference (field leads at inside bottom). (See Figure 47.) Align the lead shield on the exciter stator and mount with the capscrews and belleville washers (see Figure 44). Torque the capscrews per Figure 49. Install new lead fasteners to secure F1 and F2 to the front end bracket and conduit box.



Figure 46

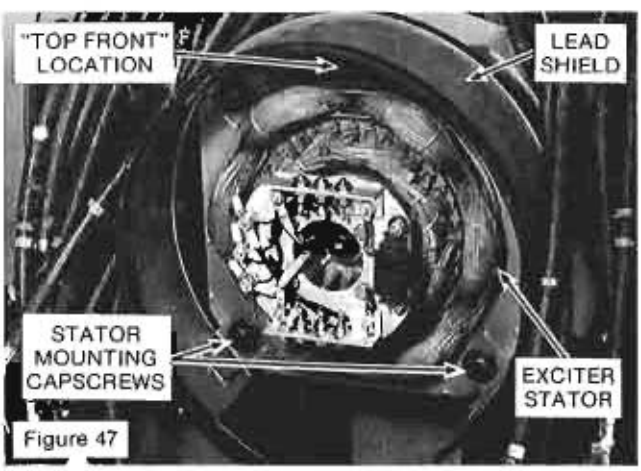


Figure 47

4. Connect the F1 and F2 leads to the corresponding F+ and F− terminals on the terminal block on the regulator panel and install the regulator enclosure. (See Figure 48).

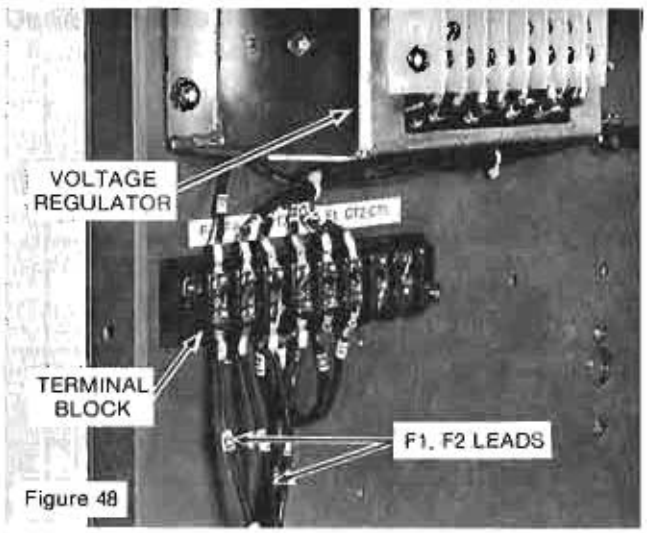


Figure 48

ASSEMBLY TO PRIME MOVER

1. Attach a suitable hoist to the generator lifting lugs, and move the generator until the generator foot mounting holes are aligned with the base and slightly above.

2. a. For two-bearing generators, align the coupling halves or sheaves between the generator and the prime mover by adding shims under the feet.

   b. For single bearing generators, if the screen assembly is mounted on the adaptor, remove the mounting bolts and remove the screen (see Figure 50). (NOTE: Do not remove the drip cover from the screen assembly if so equipped.) Insert two guide pins in the flywheel and two in the flywheel housing. Adjust the generator position until the drive discs are piloted in the flywheel. Remove the guide pins and secure the discs with Grade 8 place bolts and hardened washers or Grade 8 capscrews and heavy series lockwashers. (Torque per Figure 49.)

WARNING

DO NOT APPLY ANY FORCE TO THE GENERATOR FAN FOR LIFTING OR ROTATING THE GENERATOR ROTOR. DISREGARDING THESE INSTRUCTIONS MAY CAUSE PERSONAL INJURY OR EQUIPMENT DAMAGE.

SERVICE

ASSEMBLY

FIGURE 49: CAPSCREW TORQUE VALUES

Capscrew Diameter and Ultimate Tensile Strength (PSI) [4]	To 1/2 - 69,000 PSI To 3/4 - 64,000 PSI To 1 - 55,000 PSI			To 3/4 - 120,000 PSI To 1 - 115,000 PSI			150,000 PSI		
SAE Grade Number	1 or 2			5			8		
Capscrew Head Markings									
Capscrew Body Size (Inches) - (Thread)	Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)		
	Dry [1]	Oiled [2]	Plated [3]	Dry [1]	Oiled [2]	Plated [3]	Dry [1]	Oiled [2]	Plated [3]
1/4 - 20	5 (7)	4.5 (6)	4 (5)	8 (11)	7 (9)	6 (8)	12 (16)	11 (15)	10 (14)
- 28	6 (8)	5.4 (7)	4.8 (6)	10 (14)	9 (12)	8 (11)	14 (19)	13 (18)	11 (15)
5/16 - 18	11 (15)	10 (14)	9 (12)	17 (23)	15 (20)	14 (19)	24 (33)	22 (30)	19 (26)
- 24	13 (18)	12 (16)	10 (14)	19 (26)	17 (23)	15 (20)	27 (37)	24 (33)	22 (30)
3/8 - 16	18 (24)	16 (22)	14 (19)	31 (42)	28 (38)	25 (34)	44 (60)	40 (54)	35 (47)
- 24	20 (27)	18 (24)	16 (22)	35 (47)	32 (43)	28 (38)	49 (66)	44 (60)	39 (53)
7/16 - 14	28 (38)	25 (34)	22 (30)	49 (66)	44 (60)	39 (53)	70 (95)	63 (85)	56 (76)
- 20	30 (41)	27 (37)	24 (33)	55 (75)	50 (68)	44 (60)	78 (106)	70 (95)	62 (84)
1/2 - 13	39 (53)	35 (47)	31 (42)	75 (102)	68 (92)	60 (81)	105 (142)	95 (129)	84 (114)
- 20	41 (56)	37 (50)	33 (45)	85 (115)	77 (104)	68 (92)	120 (163)	108 (146)	96 (130)
9/16 - 12	51 (69)	46 (62)	41 (56)	110 (149)	99 (134)	88 (119)	155 (210)	140 (190)	124 (168)
- 18	55 (75)	50 (68)	44 (60)	120 (163)	108 (146)	96 (130)	170 (230)	153 (207)	136 (184)
5/8 - 11	83 (113)	75 (102)	66 (89)	150 (203)	135 (183)	120 (163)	210 (285)	189 (256)	168 (228)
- 18	95 (129)	86 (117)	76 (103)	170 (230)	153 (207)	136 (184)	240 (325)	216 (293)	192 (260)
3/4 - 10	105 (142)	95 (130)	84 (114)	270 (366)	243 (329)	216 (293)	375 (508)	338 (458)	300 (407)
- 16	115 (156)	104 (141)	92 (125)	295 (400)	266 (361)	236 (320)	420 (569)	378 (513)	336 (456)
7/8 - 9	160 (217)	144 (195)	128 (174)	395 (535)	356 (483)	316 (428)	605 (820)	545 (739)	484 (656)
- 14	175 (237)	158 (214)	140 (190)	435 (590)	392 (531)	348 (472)	675 (915)	608 (824)	540 (732)
1 - 8	235 (319)	212 (287)	188 (255)	590 (800)	531 (720)	472 (640)	910 (1234)	819 (1110)	728 (987)
- 14	250 (339)	225 (305)	200 (271)	660 (895)	594 (805)	528 (716)	990 (1342)	891 (1208)	792 (1074)

NOTES:
1. Based on use of clean, dry threads.
2. Torque reduced by 10% when engine oil is used as a lubricant.
3. Torque reduced by 20% if new plated capscrews are used.
4. Capscrews threaded into aluminum may require reductions in torque of 30% or more.

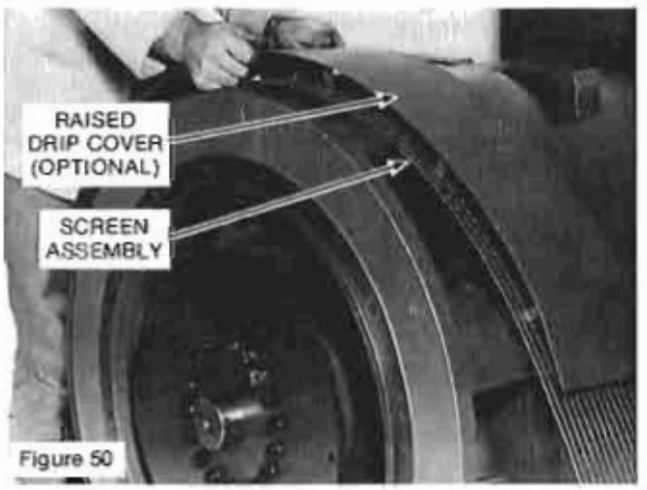


Figure 50

Position the generator so that the SAE adaptor mates with the flywheel housing.

CAUTION: DO NOT FORCE THE ALIGNMENT OF THE UNITS. SHIFT THE GENERATOR FROM SIDE TO SIDE OR RAISE OR LOWER WITH A LIFTING DEVICE AS NECESSARY.

It may be necessary to use shims under the mounting feet of either the generator or the prime mover to obtain proper alignment; use the same shims as removed under disassembly or proceed as follows: Using the extreme bottom four capscrews, mount the SAE adaptor to the flywheel housing. With a .0015 to .002 inch feeler gauge at the extreme top adaptor to flywheel housing to fit, raise the generator or lower the prime mover until the gauge is snug. Relieve just enough to release the feeler gauge and torque the remaining SAE adaptor capscrews to the flywheel housing.

Mount the screen assembly and tighten the mounting bolts.

3. Shim under the generator feet for proper support, ensuring that the generator mounting surfaces are level.

4. Install the mounting bolts which secure the generator to the mounting base.

5. For two bearing generators, assemble the coupling halves or sheave belts between the generator and the prime mover. (Follow the coupling manufacturer's instructions for assembly.)

6. Connect all existing conduit or ducting to the conduit box.

7. Connect all electrical load leads to the generator leads (or buss bars) inside the conduit box.

8. Check the exciter air gap (gap between the exciter armature and stator) by inserting a .010 inch feeler gauge in the gap and rotating it around the armature diameter to ensure that a minimum air gap is available. (See Figure 51.) If the feeler gauge cannot be rotated one full revolution, then check for a "cocked" exciter stator or loose stator mounting capscrews.

   NOTE: On single bearing units, the exciter air gap cannot be checked properly until the generator is mounted to the prime mover.



Figure 51

9. Mount the louvered conduit box cover.

10. Relubricate the bearing according to the lubrication instructions. (See Figure 52.)

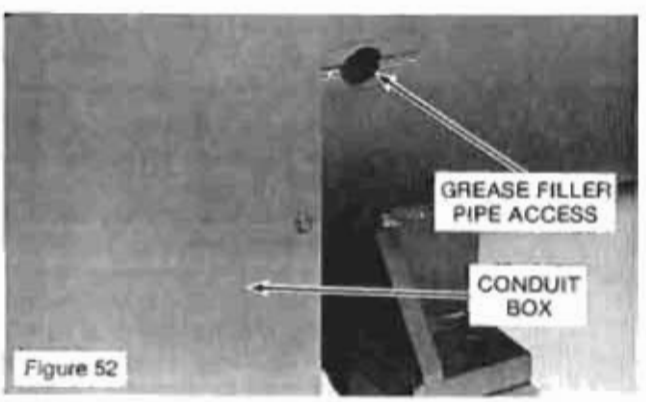


Figure 52

TROUBLE SHOOTING

GENERATOR PRODUCES NO VOLTAGE

THIS SECTION IS DIVIDED BY SYMPTOMS:

GENERATOR PRODUCES NO VOLTAGE

GENERATOR PRODUCES LOW VOLTAGE

GENERATOR PRODUCES HIGH VOLTAGE

GENERATOR VOLTAGE IS FLUCTUATING

WARNING

RESIDUAL VOLTAGE IS PRESENT AT THE GENERATOR LEADS AND AT THE REGULATOR PANEL CONNECTIONS, EVEN WITH THE REGULATOR FUSES REMOVED. CAUTION MUST BE OBSERVED OR SERIOUS PERSONAL INJURY OR DEATH CAN RESULT. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

NOTE: Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric

GENERATOR DOES NOT PRODUCE VOLTAGE

STEP 1 SHUT DOWN THE GENERATOR SET and remove conduit box cover. Check main generator leads for loose or broken connections.

STEP 2 Check regulator fuses with ohmmeter. If defective, replace.

STEP 3 Start up generator. Measure voltage at voltage regulator terminals 3 and 4. The voltmeter reading should exceed 5V ac. If it does, proceed to Step 4. If it does not, check continuity of wiring from connections 3 and 4 to the voltage source. If wiring is okay, — flashing is required. See the section on Field Flashing, page 15.

STEP 4 SHUT DOWN THE GENERATOR SET. Disconnect voltage regulator by removing the connections to terminals F+ and F- on the regulator. Connect a common 12 volt storage battery to the disconnected wires keeping polarity the same. Start up the generator set. With the generator at rated speed, read the voltage output of the unit on a voltmeter. Following these steps, if the reading is one-half or greater of the rated output when there is no load on the generator, the problem is in the voltage regulator. Consult your voltage regulator owner's manual for further information. If the reading remains near zero, the voltage regulator is okay, and the problem is further on. SHUT DOWN THE GENERATOR. Reconnect the voltage regulator. Proceed to Step 5.

STEP 5 Examine the rotating exciter for loose or broken lead wires. Be sure to check that all six rectifier connections are secure as well as all other wires on the exciter. Repair, replace or tighten as necessary. Proceed to Step 6.

STEP 6 Test each rectifier with an ohmmeter. Remove the bolted leadwire from one rectifier at the terminal stud. Test the resistance between the disconnected leadwire and the rectifier base. Make sure you have a good connection. Note the reading and reverse the ohmmeter probes. One reading should be high and the other low if the rectifier is good. If this is the case, reconnect that rectifier and proceed to the next, repeating the procedure until all six rectifiers have been checked. If the high and low readings are not achieved, the rectifier is defective and must be replaced. Torque the new rectifier to 20-30 in-lbs. Please note that two different types of rectifiers (with different polarities) are used on your unit. If all rectifiers are good, proceed to Step 7.

STEP 7 Locate the surge protector and disconnect one of the two bolted surge protector leads. With an ohmmeter, measure the resistance between the disconnected lead and the other surge protector terminal. Reverse the ohmmeter probes and repeat the test. If a high resistance is measured in both directions, proceed to Step 8. If resistance is low in one or both directions, replace the surge protector.

STEP 8 Check windings for continuity. If opens or shorts are found in the exciter armature or stator, replace the necessary component. If the condition is found in the main generator stator or rotor, major repair or generator replacement is probably required.

TROUBLE SHOOTING

NOTE: Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric

GENERATOR PRODUCES LOW VOLTAGE

STEP 1 Low voltage condition should be verified at the generator load leads with an auxiliary voltmeter.

STEP 2 SHUT DOWN THE GENERATOR SET and remove conduit box cover. Check main generator leads for correct connection.

STEP 3 Start up the generator set. Verify correct speed (1800 rpm at 60 Hertz and 1500 rpm at 50 Hertz) with a tachometer.

STEP 4 Make sure generator load does not exceed nameplate capacity. Verify this with a "clamp-on" ammeter on the main load leads. Current in any line must not exceed nameplate amps.

STEP 5 Adjust the range pot on the voltage regulator in the extreme clockwise direction to increase generator voltage as necessary.

STEP 6 Be sure the voltage adjust rheostat is adjusted, as necessary, to increase generator voltage.

STEP 7 SHUT DOWN THE GENERATOR SET. Check the sensing tap on the voltage regulator to be sure it is correct. On some applications, full line voltage is not used for regulatory sensing. Refer to the generator connection diagram.

STEP 8 Disconnect the voltage regulator by removing the connections to terminals F+ and F- on the regulator. Connect a common 12 volt storage battery to the disconnected wires keeping the polarity the same. Start up the generator set. With the generator at rated speed, read the voltage output of the unit on a voltmeter. Following these steps, if the reading is one-half or greater of the rated output when there is no load on the generator, the problem is in the voltage regulator. Consult your voltage regulator owners' manual for further information. If the reading remains near zero, the voltage regulator is okay and the problem is further on. SHUT DOWN THE GENERATOR SET. Reconnect the voltage regulator.

STEP 9 Test each rectifier with an ohmmeter. Remove the bolted leadwire from one rectifier at the terminal stud. Test the resistance between the disconnected leadwire and the rectifier base. Make sure you have a good connection. Note the reading and reverse the ohmmeter probes. One reading should be high and the other low if the rectifier is good. If this is the case, reconnect that rectifier and proceed to the next, repeating the procedure until all six rectifiers have been checked. If the high and low reading is not achieved, the rectifier is defective and must be replaced. Torque the new rectifier to 20-30 in-lbs. Please note that two different types of rectifiers (with different polarities) are used on your unit. If the rectifiers are good, proceed to Step 10.

STEP 10 Locate the surge protector and disconnect one of the two bolted surge protector leads. With an ohmmeter, measure the resistance between the disconnected lead and the other surge protector terminal. Reverse the ohmmeter probes and repeat the test. If a high resistance is measured in both directions proceed to Step 11. If resistance is low in one or both directions, replace the surge protector.

STEP 11 Check the windings for continuity. If opens or shorts are found in the exciter armature or stator, replace the necessary component. If the condition is found in the main generator stator or rotor, major repair or generator replacement is probably required.

TROUBLE SHOOTING

GENERATOR PRODUCES HIGH VOLTAGE
GENERATOR VOLTAGE IS FLUCTUATING

NOTE: Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric

GENERATOR PRODUCES HIGH VOLTAGE

STEP 1 High voltage condition should be verified at the generator load leads with an auxiliary voltmeter.

STEP 2 SHUT DOWN THE GENERATOR SET and remove conduit box cover. Check main generator leads for correct connection.

STEP 3 Start up the generator set. Verify correct speed (1800 rpm at 60 Hertz and 1500 rpm at 50 Hertz) with a tachometer.

STEP 4 Adjust the range pot on the voltage regulator in the counterclockwise direction to decrease generator voltage as necessary.

STEP 5 Be sure the voltage adjust rheostat is adjusted as necessary, to reduce generator voltage.

STEP 6 SHUT DOWN THE GENERATOR SET. Check the sensing tap on the voltage regulator to be sure it is correct. On some applications, full line voltage is not used for regulator sensing. Refer to the generator connection diagram.

STEP 7 Check the polarity of the rectifiers on the rotating rectifier. All three rectifiers on each aluminum standoff should have the identical part number. Note, however, that two different types of rectifiers (with different polarities and different part numbers) are used on each aluminum angle.

STEP 8 Disconnect the voltage regulator by removing the connections to terminals F+ and F- on the regulator. Connect a common 12 volt storage battery to the disconnected wires keeping the polarity the same. Start up the generator set. With the generator at rated speed, read the voltage output of the unit on a voltmeter. If the reading is one-half or greater of the rated output when there is no load on the generator, the problem is in the voltage regulator. Consult the voltage regulator owners' manual for further information. Shut down the generator. Reconnect the voltage regulator.

GENERATOR VOLTAGE IS FLUCTUATING

STEP 1 Adjust voltage regulator stability clockwise for increased stability.

STEP 2 Verify engine governor performance with a tachometer to insure stable engine speed.

STEP 3 SHUT DOWN THE GENERATOR SET and remove conduit box cover. Check all wiring for loose connections. Be sure that voltage adjust rheostat is properly connected and working.

STEP 4 Disconnect voltage regulator by removing the connections to terminals F+ and F- on the regulator. Connect a common 12 volt storage battery to the disconnected wires keeping polarity the same. Start up the generator set. With the generator at rated speed, read the voltage output of the unit on a voltmeter. Following these steps, if the reading is one-half or greater of the rated output and does not fluctuate when there is no load on the generator, the problem is in the voltage regulator. Consult your regulator owners' manual for further information. If the reading continues to fluctuate, the problem is further on. Shut down the generator. Reconnect the voltage regulator. Proceed to Step 5.

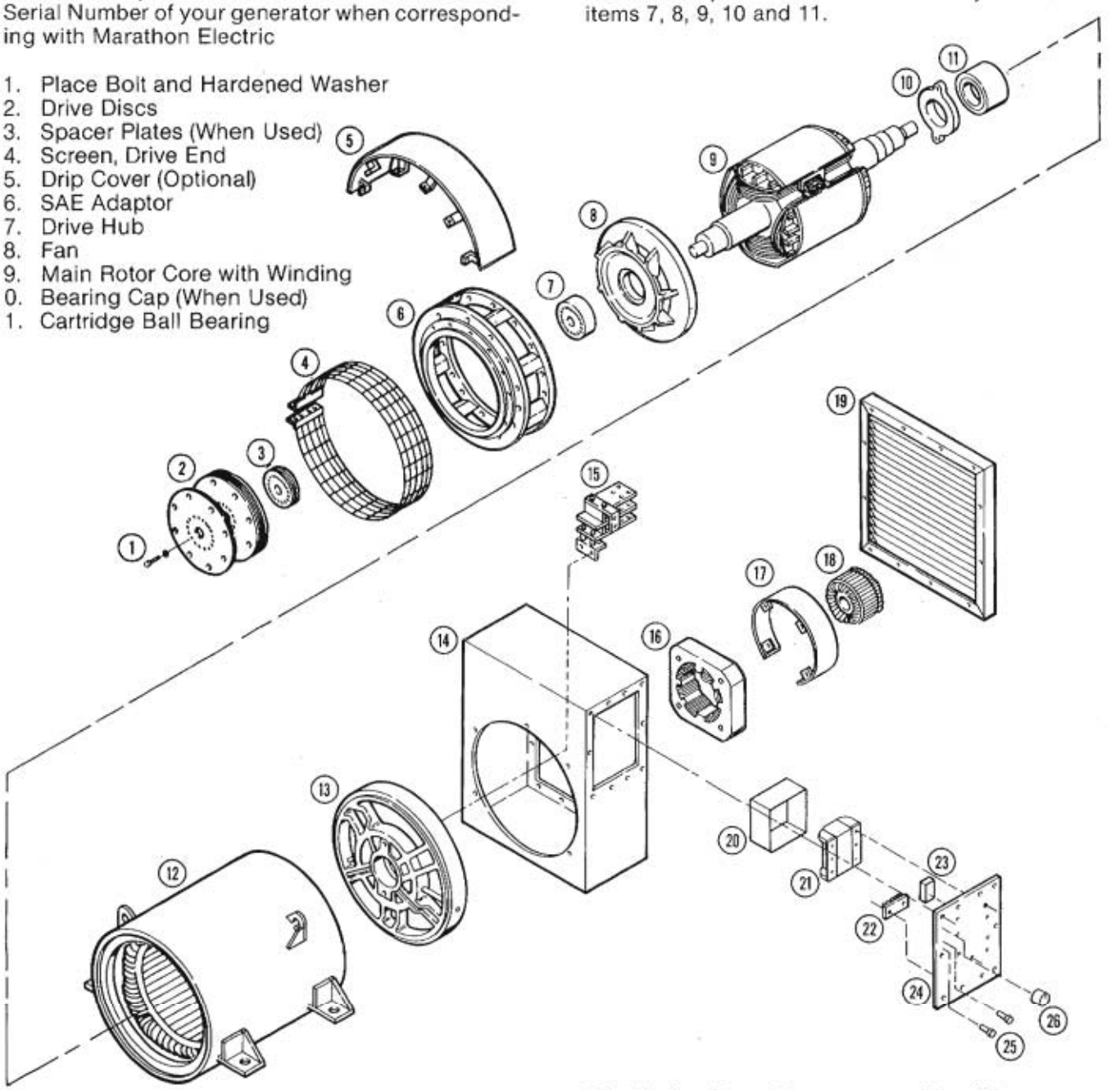
STEP 5 Check windings for continuity. If opens or shorts are found in the exciter armature or stator, replace the necessary component. If the condition is found in the main generator stator or rotor, major repair or generator replacement is probably required.

PARTS LIST

SINGLE BEARING GENERATOR PARTS LIST

NOTE: Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric

NOTE: Complete Main Rotor Assembly consists of items 7, 8, 9, 10 and 11.



1. Place Bolt and Hardened Washer
2. Drive Discs
3. Spacer Plates (When Used)
4. Screen, Drive End
5. Drip Cover (Optional)
6. SAE Adaptor
7. Drive Hub
8. Fan
9. Main Rotor Core with Winding
10. Bearing Cap (When Used)
11. Cartridge Ball Bearing
12. Main Stator and Frame Assembly with Winding
13. Front End Bracket
14. Conduit Box
15. Buss Bar Assembly (When Used)
16. Exciter Stator Assembly with Winding
17. Lead Shield
18. Exciter (Rotor) Armature and Rectifier Assembly with Winding
19. Louvered Conduit Box Cover
20. Regulator Enclosure
21. Voltage Regulator
22. Terminal Block
23. Exciter Field Circuit Breaker
24. Regulator Panel
25. Fuses and Fuse Holders
26. Voltage Adjust Rheostat

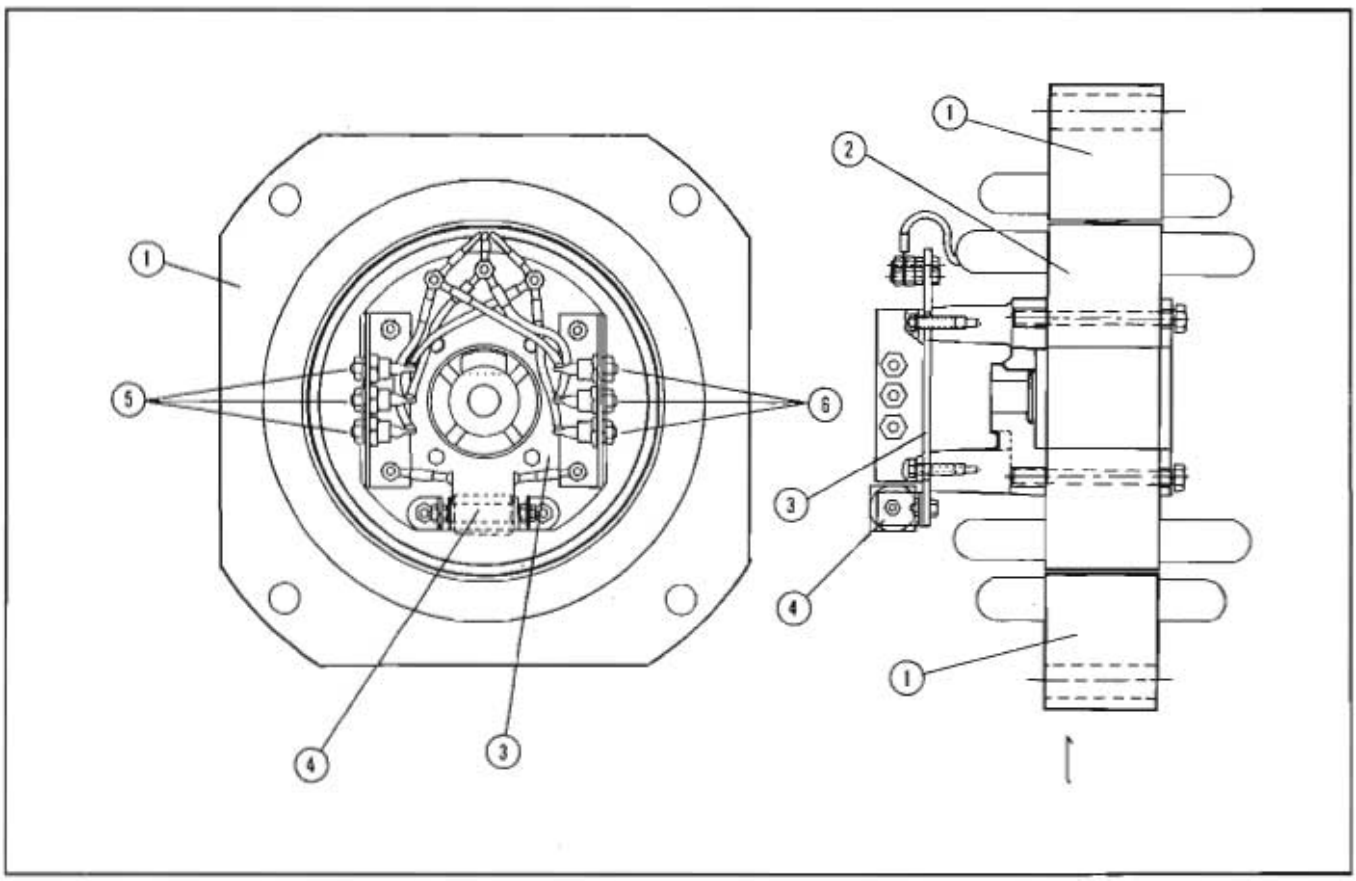
PARTS LIST

EXCITER (ROTOR) ARMATURE, STATOR AND RECTIFIER ASSEMBLY

Rectifier Mounting Torque 20-30 inch-pounds.

NOTE: Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric

NOTE: Diodes have distinct polarity and can not be interchanged.



1. Exciter Stator Assembly with Winding
2. Exciter (Rotor) Armature & Rectifier Assembly with Winding
3. Rectifier Assembly
4. Surge Protector
5. Rectifiers (Standard Polarity)
6. Rectifiers (Reverse Polarity)

PARTS LIST

RECOMMENDED SPARE PARTS

Marathon Electric recommends the following spare parts to minimize inconvenience. Always include the Model Number and Serial Number of your generator when corresponding with Marathon Electric.

ITEM	QTY.	PART NUMBER
Voltage Regulator	1	
KR-4F		A-505156
KR-4FM		A-510632
KR-4FFX		A-511682
KR-4FFMX		A-511683
KR-7F		A-505308
KR-7FM		A-510633
KR-7FFX		A-511684
KR-7FFMX		A-511685
Bearing	1	Refer to factory
Surge Protector	1	A-A509431-1
Rectifier (Standard Polarity)	3	A-A9589-6
Rectifier (Reverse Polarity)	3	A-A9681-2
Fuse	6	A-505369
Fuse Holder	2	A-505310
Voltage Adjust Rheostat	1	A-508445
Exciter Field Circuit Breaker		
For KR-4 Regulators	1	A-511162-1
For KR-7 Regulators	1	A-511162-3
Exciter Assembly (In remote areas)	1	Refer to factory

Refer to factory for other voltage regulators.

Parts may be ordered direct from:

Marathon Electric Mfg. Corp.
P.O. Box 1407
Wausau, Wis. 54401

Phone (715) 675-3311

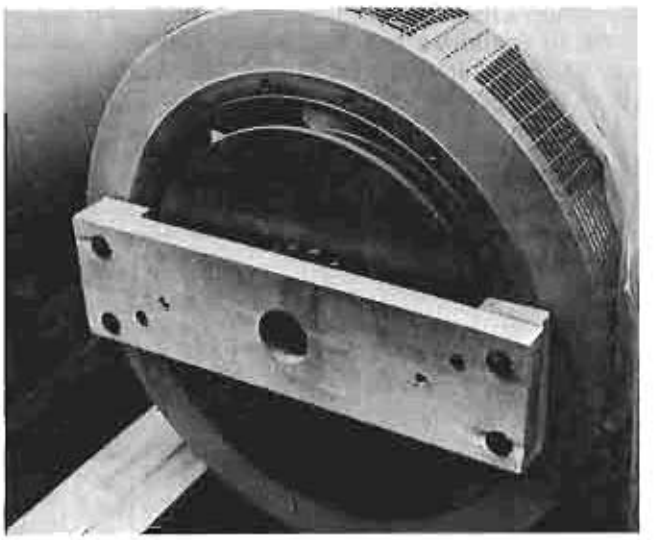
SHIPPING INSTRUCTIONS

SHIPPING INSTRUCTIONS

When installed, single bearing generator rotors are supported on the drive end by the drive discs bolted to the engine flywheel. When the engine is removed, the rotor must be supported by an appropriate fixture to prevent main rotor, main stator or exciter damage (see photo). Before shipping any generator, the main rotor must be supported by the adaptor using an appropriate fixture.

WARNING

DO NOT ATTEMPT TO TRANSPORT ANY GENERATOR WITHOUT PROPER ROTOR SUPPORT, OR EXTENSIVE EQUIPMENT DAMAGE CAN OCCUR.



NOTES

NOTES

NOTES

Sales and Service Assistance

California

ANAHEIM
625 South Euclid Suite 15
Anaheim, CA 92802
Phone: (714) 956-7111

CASTRO VALLEY
20835 Chester Street, Suite B
Castro Valley, CA 94546
Phone: (415) 889-1393

Florida

MIAMI
Alvan C. Chaney & Assoc.
117 N.E. 54th St.
Miami, FL 33137
Phone: (305) 754-8857

Illinois

CHICAGO
655 Central Ave., Unit E
Wood Dale, IL 60191
Phone: (312) 350-1800

Indiana

INDIANAPOLIS
6520 E. 82nd Street
Indianapolis, IN 46250
Phone: (317) 842-4652

Louisiana

NEW ORLEANS
5622 Perrier Street
New Orleans, LA 70115
Phone: (504) 889-5426

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MINNEAPOLIS
8700 West 36th Street
Minneapolis, MN 55426
Phone: (612) 935-8424

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SYRACUSE
Room 173 Pickard Building
5858 East Molloy Road
Syracuse, NY 13211
Phone: (315) 454-0994
454-3130

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CINCINNATI
1313 E. Kemper Rd., Suite 104
Cincinnati, OH 45246
Phone (513) 671-1677

CLEVELAND
20800 Center Ridge Rd-Suite 400
Cleveland, OH 44116
Phone: (216) 331-2910

Oklahoma

TULSA
2227 S. Garnett Road, Suite 106
P.O. Box 690115
Tulsa, OK 74169
Phone: (918) 438-3391

Pennsylvania

BRIDGEVILLE
Foster-McClinton, Inc.
2867 Washington Road
Bridgeville, PA 15017
Phone: (412) 941-4800

FOGELSVILLE
55 Snowdrift Road
Fogelsville, PA 18051
Phone: (215) 395-6880

South Carolina

GREENVILLE
100 Executive Center Drive
Greenville, SC 29615
Phone: (803) 288-8990

Tennessee

NASHVILLE
1040 Murfreesboro Road
Suite 207
Nashville, TN 37217
Phone: (615) 366-4262

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DALLAS
1366 Exchange Drive
Richardson, TX 75081
Phone: (214) 699-0251

HOUSTON
13201 Northwest Freeway
Suite 202, #1
Houston, TX 77040
Phone: (713) 462-4445

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Sandy, UT 84092
Phone: (801) 571-4484

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Electro-Power Corp.
N. 104 Madelia
P.O. Box 2983
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Australia

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32 Regent Crescent
Moorebank, NSW 2170
Australia

England

Cranfold Electrical Drives
28 Nightingales
Cranleigh, Surrey GU6 8DE
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MARATHON® ELECTRIC

100 E. Randolph Street
Wausau, WI 54401
Phone: (715) 675-3311
TWX: (910) 281-1521
TLX: 26-0175 ME WAS

MAGNA ONE GENERATORS

PERFORMANCE

TYPICAL PERFORMANCE DATA AT 60 HERTZ

GENERATOR DESCRIPTION

Basic Model (without adaptor) **684FDR8432** Test Report No. **H-SG684700 VPI**

1300 KW Continuous(**1625** KVA @ 0.8 PF) **1450** KW Standby (**1812.5** KVA @ 0.8 PF) **4160** Volts

60 Hertz **1800** RPM **6** Leads **3** Phase **Dripproof or Open** Enclosure

PERFORMANCE

Efficiency at **1300** KW

Voltage	Load	Efficiency (Includes Stray Losses)
4160	**Full**	**96.0%**
4160	**3/4**	**96.0%**

Efficiency at **1450** KW

Voltage	Load	Efficiency (Includes Stray Losses)
4160	**Full**	**96.0%**
4160	**3/4**	**96.0%**

Dynamic Characteristics

Type of Duty	Voltage	Load	Condition	% Change	Recovery
Continuous (1300 KW)	**4160**	**Full**	**Application**	**10.0**	**.9 Sec.**
	4160	**Full**	**Rejection**	**9.0**	**1.0 Sec.**
Standby (1450 KW)	**4160**	**Full**	**Application**	**11.0**	**1.0 Sec.**
	4160	**Full**	**Rejection**	**10.0**	**1.1 Sec.**

Alternate Specific Voltage KW Rating at 0.8 PF

Voltage	80° C Rise①	105° C Rise①	130° C Rise①
4160	**1150 KW**	**1300 KW**	**1450 KW**
3300	**1100 KW**	**1200 KW**	**1300 KW**

① Temperature rise by resistance.

SUBMITTAL DATA: 4160/2400V, 60 HZ, 1800 RPM

Model Number **684FDR8432**
Frame Size ..... **684 Frame**
Leads ..... **6 Leads**
Type ..... **Brushless**
Exciter Type ..... **Rotating**
Voltage Regulator ..... **Basler KR-7F (Static)**
Insulation ..... **Class F**
Number of Bearings ..... **One (1)**
Coupling ..... **Flexible Disc**
Rotor Testing ..... **25% Overspeed**
High Potential Test Voltage:
- Main Generator Stator ..... **9320 Volts**
- Main Generator Rotor with Diodes Disconnected ..... **1500 Volts**
- Exciter Generator (Field) ..... **1500 Volts**
- Exciter Generator Rotor with Diodes Disconnected ..... **1500 Volts**

Amortisseur Windings ..... **Full**

Machine Constants at ..... **1450 KW, 4160 Volts**
Short Circuit Ratio ..... **.644**
Wave Form Deviation Factor, No Load Line to Line **4.0%**
Telephone Influence Factor, Open Circuit (1960 Weightings) ..... **Less than 50**
Maximum Total RMS Harmonic Distortion, Wye Connection, Line to Line at Full Load, 0.8 PF **5%**
Maximum Single Harmonic, Wye Connection, Line to Line at Full Load, 0.8 PF **3%**
Voltage Regulation:
- No Load to Balanced Full Load Without Cross Current Compensation ..... ±1%

Synchronous Reactance Xd ..... **1.88 PU**
Transient Reactance X'd ..... **.151 PU**
Subtransient Reactance X"d ..... **.098 PU**
Negative Sequence Reactance X_2 ..... **.181 PU**
Zero Sequence Reactance X_0 ..... **.018 PU**

Note: This typical data is obtained from a duplicate unit. There may be unit to unit variations.

Prices and data are subject to change without notice.

Printed in U.S.A.

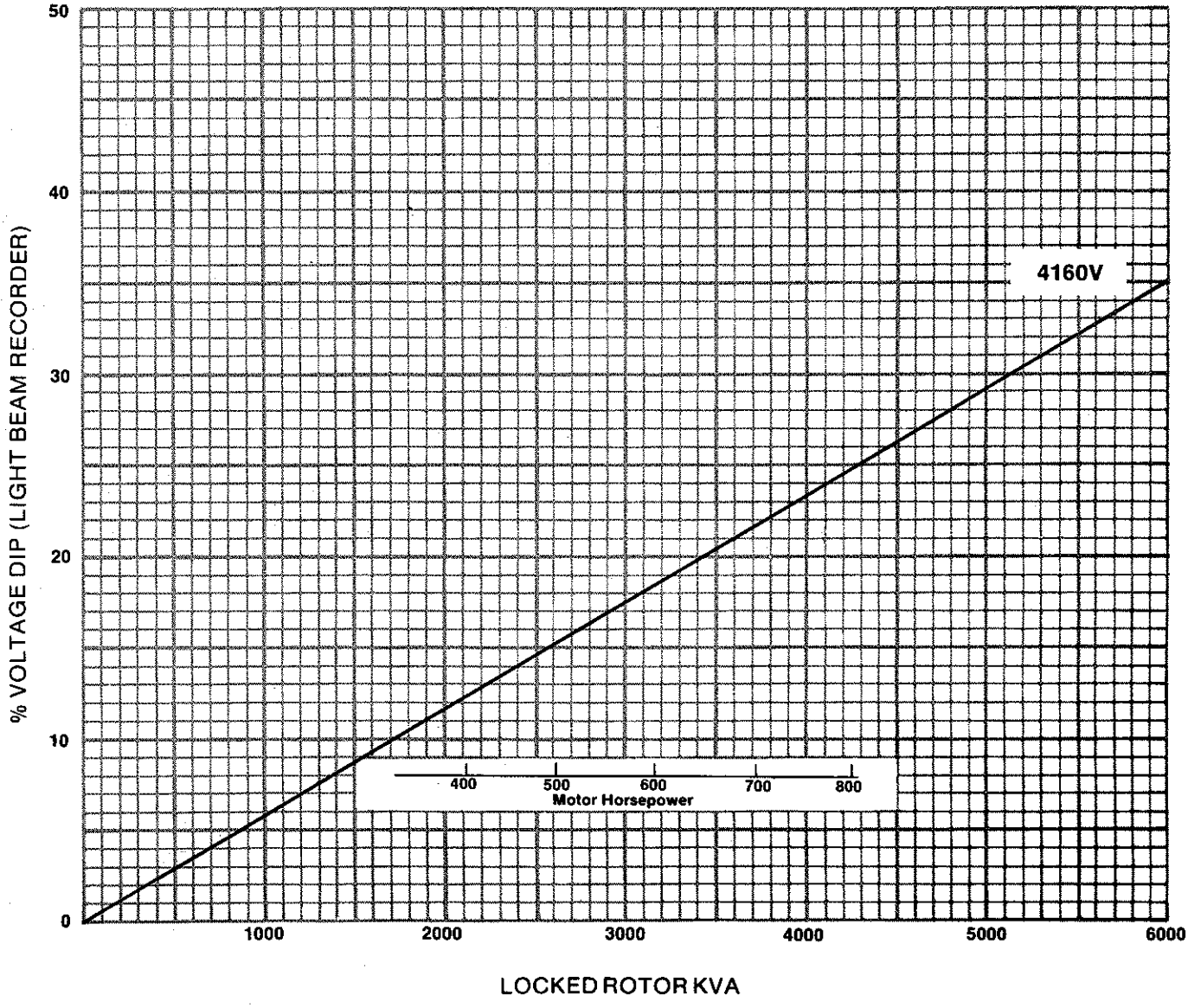
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P.O. Box 1407 Wausau, WI 54401
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MAGNA ONE GENERATORS

PERFORMANCE

TYPICAL MOTOR STARTING CURVE
60 HERTZ

Generator Model No. **684FDR8432** Test Report No. **H-SG684700 VPI**



Notes:

A. See the Introduction page of this section for qualifications.

B. The Motor Horsepower Index is based on code F (5.3 KVA/HP), three phase motors, starting across the line.

C. All curves are based on wye connected generators. Contact Marathon Electric for starting information on delta connected generators.

Prices and data are subject to change without notice.

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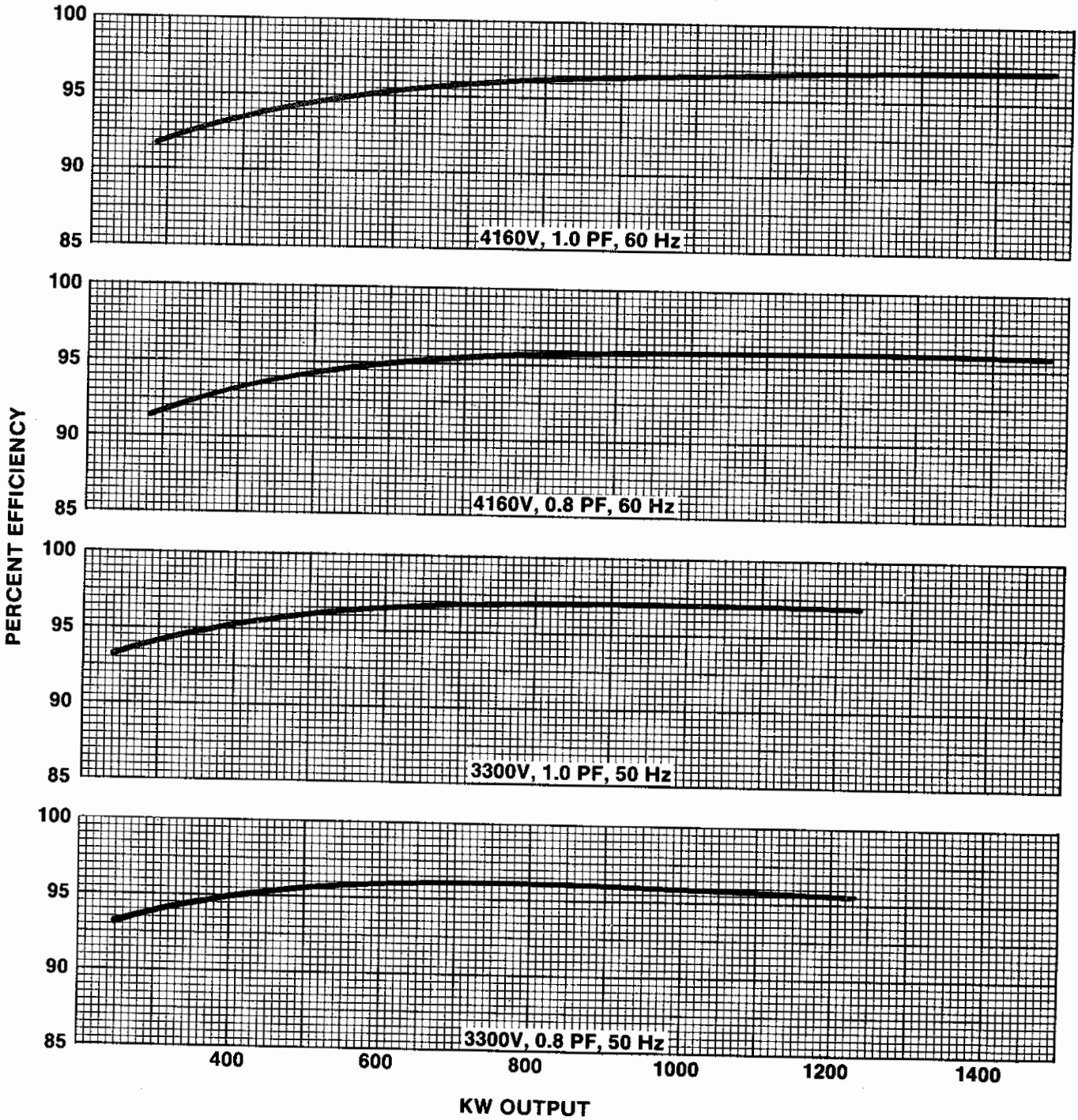
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MAGNA ONE GENERATORS

EFFICIENCY

TYPICAL EFFICIENCY DATA

Basic Model(s) 684FDR8432 **Test Report No.** H-SG684700 VPI



Note: All efficiencies are GUARANTEED to be within ± 1/2%.

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Prices and data are subject to change without notice.

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SECTION 311000 - SITE CLEARING

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. Removing existing trees, shrubs, groundcovers, plants, and grass.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Disconnecting, capping or sealing, abandoning site utilities in place, and removing site utilities.
6. Temporary erosion and sedimentation control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Division 31 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

E. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations. Comply with all Owner requirements for use of site.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

C. Utility Locator Service: Notify utility locator service “Missouri One Call System" (https://www.mo1call.com/; phone 811) for area where Project is located before site clearing.

1. Contractor shall also locate all private utilities prior to site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control, specified in Division 01 Section "Temporary Facilities and Controls," measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.

3. Erection of sheds or structures.

4. Impoundment of water.

5. Excavation or other digging unless otherwise indicated.

6. Attachment of signs to or wrapping materials around trees or plants.

F. Do not direct vehicle or equipment exhaust towards project area or fresh air intakes in surrounding buildings.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Stake site clearing limits and obtain approval of Owner's Representative prior to commencing with site clearing operations.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control requirements of authorities having jurisdiction.

B. Provide erosion, sedimentation, and water pollution control measures at all locations where drainage leaves the site.

C. Comply with EPA and Missouri DNR rules and regulations and Best Management Procedures for Storm Water Pollution Prevention.

D. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

E. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

F. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

G. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

3.3 UTILITIES

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner's Representative not less than two weeks in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner's Representative's written permission.

B. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.

4. Use only hand methods for grubbing within tree protection zone.

5. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm) and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Top soil will not be stripped and stockpiled separate from subsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate Scope of Work shown on drawings.

B. Remove slabs, paving, curbs, gutters, and aggregate base as required.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

C. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

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.

B. Reference Standard Specifications – Missouri Department of Transportation (MoDOT) Standard Specifications for Highway Construction, latest edition.

1.2 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses.
2. Excavating and backfilling for buildings and structures.
3. Subbase course for concrete walks and pavements.
4. Subbase course for asphalt paving.
5. Subsurface drainage backfill for walls and chases.
6. Excavating and backfilling for utility trenches.
7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
2. Section 311000 – Site Clearing
3. Section 315000 – Excavation Support and Protection

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course:

1. Course placed between the subgrade and cement concrete paving, footing, or floor slab.
2. The course placed between subbase course and hot mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Suitable soil imported from approved off-site sources for use as fill or backfill.

E. Class A Excavation: Removal, handling, and disposal of all materials of whatever nature encountered regardless of type, character, composition or condition thereof, except for Rock Excavation. Class A Excavation shall include the removal of clayey, silty, or sandy soil, trash and rubble, cinders, shale, chert, crushed rock, brick or cobblestone paving or surfacing, asphaltic concrete paving, and other plain, bituminous bound bases or surface courses or macadam, gravel, or broken stone.

F. Cohesive Soil: Soil that, when unconfined, has strength when air dried and cohesion when submerged in water.

G. Cohesionless Soil: Soil that, when unconfined, has no strength when air dried and has no cohesion when submerged in water. (Includes granular material.)

H. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner's Representative. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the work.

2. Open Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner's Representative. Unauthorized excavation, as well as remedial work directed by Owner's Representative, shall be without additional compensation.

I. Existing Grade: Surface elevation prior to commencement of the work.

J. Fill: Soil materials used to raise existing grades.

K. Finished Grade: Final surface elevation as shown on the Drawings.

L. Maximum Density: Maximum dry weight in pounds per cubic foot of a specific material, as determined by ASTM D698, Standard Proctor Density.

M. Optimum Moisture: Percentage of water at maximum density.

N. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for open excavation or 3/4 cu. yd. (0.57 cu. m) for pit and/or trench excavation, that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Open Excavation: Late-model, crawler-type tractor rated with at least 170-hp (127-kW) flywheel horsepower equipped with a hydraulic ripper with one digging point of standard design and size, and with tractor operating in low gear.

2. Excavation of Pit and/or Trenches: Late-model, track-mounted hydraulic excavator equipped with a ¾ cubic yard capacity rock bucket; rated at not less than 90-hp (67-kW) net flywheel horsepower, and 30,000 pound drawbar pull.

3. If the Contractor chooses to use equipment of lesser size, capacity, or power than specified above for excavating purposes, the Contractor will assume all responsibility for the cost and method of removal of materials resembling rock, which cannot be removed with their equipment. Contract change order proposals submitted by the Contractor for Rock Excavation will only be applicable if the Contractor's equipment equals or exceeds equipment requirements specified above, unless approved otherwise by Owner's Construction Representative.

O. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

P. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement.

Q. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

R. Topsoil: Fertile, friable soil which contains not more than 40% clay and not more than 55% sand as determined in accordance with ASTM D422. At least 90% of the material shall pass a No. 10 sieve and shall be free of large sticks, weeds, brush, stones larger than 1-inch in maximum dimension, and all other litter. It shall contain an amount of organic matter normal to the region with a minimum of 1% and a maximum of 6% as determined by the Loss on Ignition Test previously specified. Topsoil shall not contain oil, toxic substances, or other chemicals such as sulfides which would cause a very low pH when exposed to the air. Soils and soil material with soluble salts as carbonates, bicarbonates, and sulfates shall have a conductivity of less than 4 mmhos per cm.

S. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

T. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Tracer wire.
3. Tracer wire splice kits.
4. Tracer wire test stations.
5. Geotextiles.
6. Controlled low-strength material, including design mixture.

B. Qualification Data: For qualified testing agency.

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil and granular material proposed for installation.

2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil and granular material proposed for installation.

3. Material test reports shall be reviewed, approved, and signed by project geotechnical engineer prior to submittal to Engineer.

B. Field Quality Control test reports and logs.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.5 QUALITY ASSURANCE

A. Blasting: Blasting is prohibited.

B. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

C. Preexcavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner's Representative not less than two weeks in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner's Representative's written permission.

3. Contact utility-locator service for area where Project is located before excavating.

C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

D. Utility Locator Service: Notify utility locator service "Missouri One Call System" (https://www.mo1call.com/; phone 811) for area where Project is located before beginning earth moving operations.

1. Contractor shall also locate all private utilities prior to earth moving operations.

E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section "Temporary Facilities and Controls," are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Erection of sheds or structures.
4. Impoundment of water.
5. Excavation or other digging unless otherwise indicated.
6. Attachment of signs to or wrapping materials around trees or plants.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.7 TEST STANDARDS

A. The following test standards apply to the work under this section.

1. ASTM D2216, "Laboratory Determination of Moisture Content of Soil."
2. ASTM D422, "Particle-Size Analysis of Soils."
3. ASTM D698, "Test method for Laboratory Compaction Characteristics of Soil Using Standard Effort." (Standard Proctor)
4. ASTM D2922, "Density of Soil and Soil-Aggregate in Place by Nuclear Methods".
5. ASTM D2937, "Density of Soil in Place by the Drive-Cylinder Method."
6. ASTM D3017, "Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods."

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide approved borrow soil materials when sufficient suitable soil materials are not available from excavations. All borrow soil and granular materials shall be provided from MoDOT approved sources.

1. Comply with the requirements of MoDOT's Missouri Standard Specifications for Highway Construction, Section 203, Roadway and Drainage Excavation, Embankment, and Compaction for environmental clearances for borrow material sources.

B. Satisfactory or Suitable Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 2 inches (50 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Satisfactory or Suitable Soils located within 36" of finished grade in lawn and planter areas shall be limited to cohesive soils in Soil Classification Groups ML, CL, and CH, or a combination of these groups, free of rock or gravel larger than 1 inch in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter, subject to approval of Owner's Representative.

2. Liquid Limit: < 50.

3. Plasticity Index: plots above the A-line.

C. Unsatisfactory or Unsuitable Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory or Unsuitable soils also include suitable soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand complying with the requirements of Section 1007 of the MoDOT Standard Specifications for Highway Construction.

1. Type 1 Aggregate

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand complying with the requirements of Section 1007 of the MoDOT Standard Specifications for Highway Construction.

1. Type 1 Aggregate

F. Bedding Course: 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 (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

G. Drainage Fill: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

H. Granular Backfill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 100 percent passing a 3/4-inch (18.75-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

I. Waste Rock: Graded mixture of natural or crushed limestone screenings having the following gradation:

Sieve Size	Percent Passing
3/8-inch	100 %
#4 sieve	90 – 100 %
#8 sieve	85 – 100 %
#40 sieve	40 – 60 %
#80 sieve	15 – 40 %
#200 sieve	15 – 30 %

J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polypropylene fibers; with elongation greater

than 50 percent; complying with AASHTO M 288 and the following minimum average roll values, measured per test methods referenced, Mirafi 160N or approved equal.

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Grab Tensile Elongation: 50%; ASTM D 4632.
4. Trapezoidal Tear Strength: 60 lbf; ASTM D 4533.
5. Sewn Seam Strength: 142 lbf; ASTM D 4632.
6. Tear Strength: 60 lbf; ASTM D 4533.
7. Puncture Strength: 95 lbf; ASTM D 4833.
8. Apparent Opening Size: No. 70 U.S. sieve; ASTM D 4751.
9. Permittivity: 1.4 per second, minimum; ASTM D 4491.
10. Permeability: 0.22 cm/sec; ASTM D 4491.
11. UV Stability: 70 percent strength retained after 500 hours' exposure; ASTM D 4355.
12. Flow Rate: 110 gpm/ft^2; ASTM D 4491

B. Soil Reinforcement Geotextile: Woven geotextile fabric, manufactured for soil reinforcement applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
3. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
4. Tear Strength: 90 lbf (400 N); ASTM D 4533.
5. Puncture Strength: 90 lbf (400 N); ASTM D 4833.
6. Apparent Opening Size: No. 30 (0.60-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

C. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
3. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
4. Tear Strength: 90 lbf (400 N); ASTM D 4533.
5. Puncture Strength: 90 lbf (400 N); ASTM D 4833.
6. Apparent Opening Size: No. 30 (0.60-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Low-density, self-compacting, flowable concrete material of low to moderate strength, low permeability, and minimal shrinkage, as follows:

1. Portland Cement: ASTM C 150, Type I.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33, 3/4-inch (19-mm) nominal maximum aggregate size.
4. Water: ASTM C 94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.

B. Produce conventional-weight, controlled low-strength material with 80-psi (28-day) compressive strength when tested according to ASTM C 495; permeability, maximum 1 x 10^{-6} cm/sec.; shrinkage less than 0.5%

C. Flowable backfill complying with Section 621 of the MoDOT Standard Specifications for Highway Construction.

2.4 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems, with the words “CAUTION WATER LINE BURIED BELOW”
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems, with the words “CAUTION WATER LINE BURIED BELOW”
5. Green: Sewer systems.

C. Trace Wire:

1. Tracer wire shall be #14 AWG Solid, steel core soft drawn high strength tracer wire, 250# average tensile break load, 30 mil high molecular weight-high density blue polyethylene jacket complying with ASTM-D-1248, 30-volt rating. No

THHN insulated wire shall be allowed. Tracer wire shall be Copperhead Industries HS-CCS or approved equal.

2. Tracer wire shall have moisture resistant splices for direct bury applications. Splices shall be Copperhead Industries Snakebite or 3M DBR or approved equal.

3. Tracer wire test stations shall be designed to be easily detected by magnetic and electronic locators. A magnet shall be securely attached at the top of the upper tube of the box for locating purposes. Lid shall be blue and have a brass terminal for attaching locating equipment and a brass 5-sided nut for removing cap. Tracer wire test station shall be Copperhead Industries Snake Pit or approved equal.

PART 3 - EXECUTION

3.1 COORDINATION

A. Contractor shall coordinate all excavation work to be performed to avoid duplication of effort and to make maximum use of an open excavation by all trades.

B. At least 72 hours prior to excavating, Contractor shall complete utility locates in the construction area for all public and private utilities.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.3 SAFETY

A. The means of the work and the safety of the Contractor's employees are solely the responsibility of the Contractor.

B. The Contractor has a contractual obligation to comply with all applicable laws and regulations including those of OSHA.

C. At no time will either the Owner or Owner's Representative take responsibility for either the means of the work or the safety of the Contractor's employees.

3.4 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

C. Labor and equipment required to maintain all excavations free from water at all times during the work shall be provided until backfill is completed.

D. Water shall be disposed of in a manner that will not cause ponding in the work area or hamper or damage in any way the work of other trades.

E. Care shall be taken to avoid contaminating existing sewer systems with sediment or debris from Contractor's pumping operations.

F. Contractor shall clean any such deposits from sewer systems upon completion of his work at no additional cost to Owner.

G. Work on this project will potentially expose the Owner's existing utilities and structures to water if excavations become flooded.

H. Contractor shall keep all excavations dewatered at all times to include non-working hours.

3.5 EXPLOSIVES

A. Explosives: Explosives are prohibited. Do not use explosives.

3.6 EXCAVATION, GENERAL

A. Earthwork shall be carried out so as to minimize the impact on existing trees and landscaping.

B. The Contractor shall design, provide and maintain at all times the necessary shoring, bracing and sheet piling for proper protection of excavated areas from cave-ins or for protection of existing structures or utilities from damage.

C. Contractor shall provide temporary supports for all underground utilities crossing an excavation. Prior to excavating provide information to Owner's Representative indicating the method of supporting telephone and electric duct banks.

D. All excavated areas shall be properly barricaded for personnel protection.

E. Excavation shall consist of the removal of all earth, rocks, boulders, concrete, roots or any other materials that are found within the limits of the excavation or that interfere with the work as indicated on the Drawings or as specified herein.

F. The bottoms of all excavations shall be properly leveled, loose materials removed and all excavations maintained in good condition by keeping dry and free from debris, ice, and frost until the concrete has been placed. Any overexcavation shall be brought back to proper grade with suitable soil compacted as specified herein at no additional cost to Owner.

G. In excavations where the surface has been disturbed by construction activities, the soil shall be compacted in place commensurate with the allowable soil bearing pressure or the disturbed soil shall be removed and replaced with suitable soil compacted to meet the minimum density requirements of this Specification at no additional cost to Owner.

H. When unsuitable materials or soil with insufficient strength are encountered below the bottom of an excavation, such unsuitable material or soil shall be removed and replaced with suitable soil compacted to meet the specified density requirements. Payment for this work shall be made in accordance with the General Conditions.

I. Unless otherwise noted, concrete bases and walls will be formed. Excavations shall be overdug as necessary to stabilize sides of areas and permit working room for forming.

J. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as Class A Excavation and Rock Excavation. Do not excavate rock until it has been classified by Owner's Representative. The Contract Sum will be adjusted for rock excavation in accordance with the Contract Documents. Changes in the Contract time may be authorized for rock excavation.

1. Intermittent drilling, ram hammering, or ripping of material not classified as rock excavation is Class A Excavation.

2. Rock Excavation includes removal and disposal of rock.

3.7 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

3.8 EXCAVATION FOR WALKS AND PAVEMENT

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.9 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.

C. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: Minimum 4 inches (100 mm) each side of pipe or conduit.

D. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Grade trench bottom to provide a smooth, firm, stable, and rock free foundation throughout the length of the piping. All rock greater than one inch in diameter found in the trench shall be removed for a depth of six inches below the bottom of the pipe and replaced by suitable bedding material.

2. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with crushed stone as indicated on the drawings.

3. Provide layers of crushed stone in the bottom of trench. Shape stone layer to fit bottom of piping. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.10 SUBGRADE INSPECTION

A. Notify Contractor's geotechnical engineer and Owner's Representative when excavations have reached required subgrade.

B. If geotechnical engineer determines that unsuitable soil is present, advise Owner's Representative. After receiving approval of Owner's Representative, continue excavation and replace with compacted backfill or fill material as directed by geotechnical engineer.

C. Proof-roll subgrade below slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph (5 km/h).

2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).

3. Excavate soft spots, unsuitable soils, and areas of excessive pumping or rutting, as determined by geotechnical engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by geotechnical engineer or Owner's Representative, without additional compensation.

F. The subgrade for all structures and paved areas, including items such as roadways and parking areas and the subgrade under the utility trenches and manholes, shall be prepared by compacting the top 12" of soil to the minimum densities hereinafter specified under Backfilling.

3.11 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by geotechnical engineer and Owner's Representative.

1. Fill unauthorized excavations under other construction or utility pipe as directed by geotechnical engineer, subject to approval of Owner's Representative.

3.12 STORAGE OF SOIL MATERIALS

A. Unless otherwise noted suitable excavated material may be used as backfill provided the compaction requirements are met. No large rocks or stones, frozen material, trash or rubble of any kind shall be used in the backfill.

B. Contractor for his convenience may use imported material for backfill.

C. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations.
2. Do not store within drip line of remaining trees.
3. Stockpile soil materials only in designated areas approved by the Owner's Representative.

3.13 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
8. Inspection and written approval of work to be covered by Owner's Representative.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. When granular material is used in areas to be planted provide 30" suitable cohesive soil layer plus 6" of top soil. Soil backfill shall be subject to approval of Owner's Representative.

3.14 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of subbase or base course material at 95 percent.

C. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of base course material at 95 percent.

D. On prepared subgrade, place subbase and base course as follows:

1. Shape subbase and base course to required crown elevations and cross-slope grades.

2. Place subbase and base course 6 inches (150 mm) or less in compacted thickness in a single layer.

3. Place subbase and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

4. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.15 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."

D. Provide 4-inch- (100-mm-) thick, concrete cradle support for piping or conduit less than 24 inches (600 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of suitable soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.

2. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.16 SOIL FILL

A. Scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use suitable soil materials placed to an elevation of 6-inches below finished grade.

2. Scarify the top 6" of soil in grass and planted areas in two directions prior to placing topsoil.

3. Place all topsoil and complete all finish grading in grass and planted areas.

4. Under pavements, steps and ramps, use granular base course.

5. Under footings and foundations, use granular base course.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.17 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.18 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 9 inches (225 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 95 percent.

3. For utility trenches, compact each layer of bedding and initial backfill material at 95 percent.

4. Under lawn or unpaved areas, compact each layer of backfill or fill soil material at 85 percent.

5. For cohesive soils the moisture shall be controlled between -1% to +3% of optimum.

D. Jetting, as a method of backfill compaction, will not be allowed.

3.19 **TOPSOIL PLACEMENT**

A. For grass and planted areas bring subgrade to elevation suitable for placement of topsoil.

B. Furnish and install topsoil for areas to be seeded, sodded, or planted.

C. Areas to receive topsoil shall be cleaned by Contractor of all sticks and stones larger than 1" in maximum dimension and all other debris and rough graded to the required subgrade elevations.

3.20 **SEEDING/SODDING**

A. Furnish and install seeding and sodding.

3.21 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).

2. Walks: Plus or minus 1 inch (25 mm)

3.22 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent geotechnical engineering testing agency to monitor site operations, assure compliance with earthwork specifications, verify that actual conditions are compatible with recommended design, evaluate foundation and trench bearing surfaces, observe fill, backfill, and foundation placement, perform field quality-control testing.

B. Allow testing agency to inspect and approve all fill, backfill, bedding, base, and subbase materials. Proceed with placement only after receiving approval of geotechnical engineer.

C. Allow testing agency to inspect and test subgrades prior to constructing improvements and each subsequent fill, subbase course, base course, bedding, or backfill layer. Proceed with subsequent earthwork or construction only after test results for previously completed work comply with requirements.

D. Structure Subgrade: At structure subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Additional tests shall be completed as required by geotechnical engineer.

E. Testing agency shall test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. At a minimum, tests will be performed at the following locations and frequencies. Additional testing shall be completed as required by geotechnical engineer.

1. Pavement and Structure Slab Areas: At subgrade and at each compacted fill, subbase course, base course, and backfill layer, at least 1 test for every 500 sq. ft. or less of paved area or structure slab, but in no case fewer than 3 tests.

2. Structure Backfill: At subgrade and at each compacted base course and backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

3. Trench Backfill: At subgrade and each compacted bedding course and backfill layer, at least 1 test for each 100 feet or less of trench length, but no fewer than 2 tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.23 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.24 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 315000 – EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.

B. Related Sections:

1. Section 312000 – Earth Moving
2. Section 311000 – Site Clearing

1.3 PERFORMANCE REQUIREMENTS

A. Design**,** furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Delegated-Design Submittal: Excavation support and protection system signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For qualified professional engineer.

C. Informational Submittals:

1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
    a. Existing utilities and subsurface conditions.
    b. Proposed excavations.
    c. Proposed support and protection systems.
    d. Coordination with dewatering systems.
    e. Provisions for tunneling operations and loads.
    f. Monitoring of excavation support and protection system.
    g. Working area location and stability.
    h. Coordination with waterproofing.
    i. Abandonment or removal of excavation support and protection system.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
    1. Notify Owner's Representative no fewer than two weeks in advance of proposed interruption of utility.
    2. Do not proceed with interruption of utility without Owner's Representative's written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
    1. Review benchmark locations with Owner's Representative for approval.
    2. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner's Representative if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
    3. Provide additional benchmarks as directed by the Owner's Representative where there is evidence of cracks, sags, or other damage to adjacent construction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
    1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally as required to secure soldier piles.

3.3 TIEBACKS

A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protections system.

2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.4 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Owner’s Representative.

2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Excavation and support protection systems shall be removed completely, unless approved otherwise in writing by the Owner's Representative.

2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earthwork."

3. Repair or replace, as approved by Owner's Representative, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 321216 – ASPHALT PAVING

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.

B. Reference Standards: Missouri Department of Transportation Standard Specifications for Highway Construction (MoDOT Standard Specifications), latest edition.

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt patching.
2. Pavement-marking paint.

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: For each job mix proposed for the Work.

B. Qualification Data: For qualified manufacturer and installer.

C. Material Certificates: For each paving material, from manufacturer.

D. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Missouri Department of Transportation.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Missouri Department of Transportation and for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone or crushed gravel.

C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt pavement will be designed according to:

1. Roadway: AASHTO Guidelines for Design of Pavement Structures, 1986
2. Parking Lot: The Asphalt Institute

B. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

C. Asphalt Cement: ASTM D 946 for penetration-graded material.

D. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70.

E. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

1. Color:
   a. White: Crosswalk
   b. Yellow: Centerline
   c. Blue: Accessible spaces and areas.

B. Glass Beads: AASHTO M 247, Type 1.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Surface Course: MoDOT Standard Type BP-2 Bituminous Pavement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt surface course in single lift.
2. Spread mix at minimum temperature of 250 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
3. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Surface Course: 1/8 inch.

3.8 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner's Representative.

1. Replace pavement markings that were removed during construction operations.

2. Restripe parking spaces as indicated.

3. Coordinate with Owner's Representative on location of pavement markings.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.

b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 337119.13 – ELECTRICAL UNDERGROUND DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to the Work specified in this Section.

1.2 SCOPE

A. The Contractor shall furnish and install all electrical underground ducts and duct banks as specified herein and as shown on the Drawings.

B. The Contractor shall furnish and install underground junction boxes, control conduit and pull tape for installation for the MU Energy Management control system fiber optic network as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

A. Division 03 – Concrete

B. Section 260500 – Common Work Results for Electrical

C. Section 260526 – Grounding and Bonding

D. Division 31 – Earthwork

1.4 SUBMITTALS

A. Manufacturer's product data sheets shall be submitted for the following items:

1. Each type of conduit (galvanized rigid steel, Schedule 40 PVC, DB-60 PVC)
2. Fiberglass long radius elbows
3. Intumescent silicone sealant
4. Protective coating for direct buried metal conduit
5. Underground conduit warning tape
6. Conduit pull tape
7. Conduit/duct plugs
8. Conduit spacers for conduit duct banks
9. Red cement coloring dye for concrete encased 4.16 kV conduit duct banks

1.5 QUALITY ASSURANCE

A. All material and equipment must be new and must be UL listed and labeled.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect stored conduit from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing indoors.

B. Store plastic conduit protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduit shall be new and shall be approved and listed by Underwriters' Laboratories, Inc. (UL) and shall bear the UL label of approval.

B. All conduit shall be one of the following:

1. Galvanized rigid steel conduit, “Heavywall” (GRC), shall be Schedule 40 steel conduit, hot dipped galvanized on both the outside and the inside. Conduit as obtained from the manufacturer shall have been cut and threaded before galvanizing, thereby insuring the galvanizing of these areas. Conduit shall conform to the latest editions of the Federal Specifications WW-C-581d, ANSI Standard C80.1, and UL Standard No. 6.

    a. GRC shall be used below grade as specified herein and as shown on the Drawings.

2. Rigid non-metallic conduit shall be heavy wall Schedule 40 (NEMA EPC-40 PVC, Type II-III) polyvinyl chloride (PVC) electrical plastic conduit. All fittings shall be cemented using an approved PVC solvent cement. Rigid non-metallic conduit shall be as manufactured by Carlon Electrical Products; Condux International, Inc.; Can-Tex Industries; Certainteed Products Corp.; or approved equal.

3. Type DB-60 polyvinyl chloride (PVC) conduit, designed for use in concrete encasement applications, rated for 90°C cable and meeting NEMA Standard TC-6 and ASTM F-512 for underground applications may be used in lieu of Schedule 40 PVC conduit. Type DB-60 conduit shall be as manufactured by Carlon Electrical Products, Condux International, Inc., Certainteed Products Corp. or Can-Tex Industries.

4. Fiberglass long radius elbows shall be provided for 4.16 kV duct banks and shall be 48” minimum radius for horizontal bends and 36” minimum radius for vertical bends.

2.2 INTUMESCENT SILICONE SEALANT

A. Intumescent silicone sealant shall meet UL Water Leakage Test – Class 1 requirements and shall be re-enterable and repairable; 3M Fire Barrier Water Tight Silicone Sealant 3000WT or approved equal.

B. Fire barrier packing material for use with 3M UL listed 3000WT intumescent silicone sealant shall be 3M Fire Barrier Packing Material PM4 or mineral wool.

2.3 PROTECTIVE COATING FOR DIRECT BURIED METAL CONDUIT

A. Protective coating for direct buried metallic conduit shall be Kop-Coat, Inc. Bitumastic No. 50 or two coats of 3M Scotchrap pipe primer over wrapped in accordance with the manufacturer's written instructions with 3M No. 51, 20 mil thick tape.

2.4 UNDERGROUND CONDUIT WARNING TAPE

A. Warning tape shall be fabricated from polyethylene film, and shall be 6 inches wide and not less than 3.5 mils thick.

B. Warning tape for electric duct banks and all directly buried electrical conduits shall be high visibility red in color and imprinted at frequent intervals with black letters having the following wording:

CAUTION BURIED ELECTRIC LINE BELOW

C. Warning tape shall be Terra-Tape "Extra Stretch" manufactured by Reef Industries, Inc., or approved equal, by EMED Co., Inc., Seton, W. H. Brady Co., or Allen Systems, Inc.

2.5 CONDUIT PULL TAPE

A. Low-stretch polyester flat, woven tape with minimum 2500 lb. rating.

B. Rot and mildew resistant.

C. Permanently printed sequential measurements at one-foot increments.

D. Pull tape shall be Neptco Muletape WP2500P or approved equal.

2.6 CONDUIT/DUCT PLUGS

A. Plugs for sealing empty underground conduits and ducts in manholes, handholes and at entry to floor mounted and outdoor pad-mounted equipment shall be compressible natural rubber with stainless steel plate on both sides with stainless steel bolt and stainless steel wing nut or hex nut for compressing the rubber plug between the two stainless steel plates to secure it inside the conduit or duct or shall be all plastic/rubber with no metal parts.

B. Conduit/duct plugs shall be T-Cone Plug by ETCO Specialty Products or Blank Duct Plug by Calam or approved equal by Osbourne Associates, Inc.

2.7 DUCT BANK CONDUIT SPACERS

A. Conduit spacers shall be as manufactured by Formex Manufacturing, Inc., Carlon Electrical Products, Condux International, Inc., Certainteed Product Corp. or Can-Tex Industries.

2.8 CONCRETE ENCASEMENT

A. ADMIXTURES

1. Air-entraining mixture shall be used for all exterior concrete and shall conform to ASTM C260. The total calculated air content by volume as determined by ASTM C231 shall be as follows:

Maximum Course Aggregate Size	Total Air Content, % (Includes Trapped Air)
3/4"	3-8
1”	4-6

2. Water reducing admixture shall be used to reduce the total water requirements of ASTM C494, Type A.

3. Calcium chloride or accelerating admixtures containing calcium chloride shall not be used.

B. PROPORTIONING

1. Concrete slump at the time of placement as determined by ASTM C13 shall be 3” or 4”. Tolerance up to 1” above maximum will be allowed providing average batches tested does not exceed maximum.

2. The minimum 28-day concrete compressive strength for concrete shall be 4,000 psi (6 sacks/cu yd minimum).

C. REINFORCEMENT

1. All concrete encased electrical conduit duct banks shall contain steel reinforcing throughout the entire length as indicated in the standard details on the Drawings. The minimum size of reinforcing steel shall be size No. 4.

D. BACKFILL

1. Backfill material shall be compacted satisfactory soil in accordance with Specification 312000 – Earth Moving or ¾” minus waste rock fill. No concrete or large rocks are to be used.

E. 4.16 kV DUCT BANK CONCRETE COLOR ADDITIVE

1. The concrete for all concrete encased 4.16 kV duct banks shall have a medium color additive with a minimum concentration per the manufacturer’s recommendation per yard of concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. UNDERGROUND CONDUIT

1. Unless otherwise indicated, all underground conduit located outside building areas shall have a minimum slope of 1/2% toward the drainage point or as shown on the Drawings, and shall be a minimum of three feet (3'-0") below finish grade to the top of the conduit.

2. Trenching, excavation, and backfilling for all underground conduit shall be accomplished as hereinafter specified or shown on the Drawings.

3. Trench widths shall be kept to a minimum and bottoms shall be graded to a uniform slope. The bottom of the trench shall be kept free of water. If required to protect the excavation or personnel, shoring and sheeting of a design and materials suitable to maintain the trench in a safe and workable condition shall be provided. Adequate barricades shall be installed around excavations to protect workmen and the public during the construction. Provide temporary supports for all underground utilities crossing an excavation.

4. Conduit in trenches shall be supported throughout the entire length on solid earth.

5. Underground conduit shall be rigid galvanized steel for a minimum of eight (8) feet from building walls at all penetrations. PVC conduit shall not be used at penetrations.

6. All metallic conduit directly buried in earth shall be factory PVC coated with field applied PVC coating at joints or completely coated with two 15- to 18-mil thick coats of

an approved bitumastic coal tar protective coating or two coats of 3M Scotchrap pipe primer overwrapped in accordance with the manufacturer's written instructions with 3M No. 51 tape before the conduit trench is backfilled.

7. Backfill for trenches containing direct buried conduit shall be in accordance with Division 31 – Earthwork. Any settlement shall be corrected by refilling and retamping. No puddling will be permitted.

8. Underground conduits shall be at least 12 inches away from gas, water, steam or other pipe lines and steam tunnels, chases or manholes.

9. Individual direct buried conduits shall have long swept elbows.

   a. Size 2" and below – 24" minimum radius

   b. Size 2-1/2" and above – 36" minimum radius

10. Factory elbows for underground conduits in sizes 2 inches and larger shall be fiberglass.

11. Couplings for conduits in a common trench shall be staggered at least 6 inches. All joints shall have watertight seals.

12. Install PVC bell end fittings at each PVC conduit termination. Bell fittings shall be grouted flush with the inside surface of the handhole wall.

13. All PVC conduit joints shall be sealed using the adhesive joint solvent cement recommended by the manufacturer of the PVC conduit to prevent conduit joints from separating during construction and pulling in cable.

14. All PVC conduit couplings and end bells shall be properly glued to the conduit, pushing the conduit all the way in to the stop on the coupling/end bell.

15. Upon completion of the conduit installation, Contractor shall swab out conduits to remove any rocks and debris. Swabbing shall be conducted with Owner's Representative present. Owner's Representative shall be notified a minimum of 24 hours prior to swabbing.

16. All conduits shall have a polyester pull tape, as specified herein, installed for future use. Pull tape shall have permanently printed sequential measurements at one-foot increments. Wire shall not be used.

17. Provide 10' of spare length of pull tape at both ends and terminate on conduit/duct plug inside junction boxes, handholes and manholes.

B. ELECTRICAL CONDUIT DUCT BANKS

1. Underground concrete encased 4.16 kV electrical conduit duct banks shall consist of either Schedule 40 or Type DB-60 polyvinyl chloride (PVC) conduit encased in reinforced concrete, providing an underground connection of raceways as shown on the Drawings.

2. All other conduit duct banks, whether indicated on the Drawings to be encased in non-dyed concrete or to be installed without concrete encasement shall be Schedule 40 PVC conduit.

3. The size and quantity of all electrical duct bank conduit shall be as indicated on the Drawings.

4. Conduits shall have long sweep elbows, 48" minimum radius for horizontal bends and 36" minimum radius for vertical bends. Factory elbows for conduit sizes 2 inches and larger shall be fiberglass.

5. Couplings for conduits in a conduit duct bank shall be staggered at least 6 inches. All joints shall have watertight seals.

6. Install PVC bell end fittings at each PVC conduit termination. Bell fittings shall be grouted flush with the inside surface of the handhole wall.

7. All PVC conduit joints shall be sealed using the adhesive joint solvent cement recommended by the manufacturer of the PVC conduit to prevent conduit joints from separating during construction and pulling in cable.

8. All PVC conduit couplings and end bells shall be properly glued to the conduit, pushing the conduit all the way in to the stop on the coupling/end bell.

9. Underground electrical conduit duct banks shall be installed a minimum of 36 inches below finish grade to the top surface of the duct bank, unless otherwise indicated.

10. The duct bank conduit shall be rigid galvanized steel in all locations subject to vehicular traffic where the depth of the duct bank is less than 36 inches below finish grade to the top surface of the duct bank or as indicated on the Drawings.

11. Underground electrical conduit duct banks shall be at least 12 inches away from all other underground utilities; gas, water, steam, telephone, communications, etc., and at least 36 inches away from steam pipe lines and steam tunnels, chases or manholes.

12. Conduits shall be installed with minimum slope of 1/2% toward manholes or other drainage point as shown on the Drawings.

13. The maximum change in direction in any plane between lengths of straight rigid conduit without the use of bends shall be limited to 5 degrees.

14. Each underground conduit in concrete encased duct banks shall have a minimum of 3 inches and a maximum of 6 inches of concrete around it in all directions.

15. Intermediate and base spacers shall be used to obtain uniform separation and alignment during the installation of the concrete. Maximum intervals between spacers shall be 8 feet.

16. Upon completion of the installation of the duct bank demonstrate to the Owner's Representative that all conduits are clear of obstructions by pulling a mandrel 1/2-inch smaller than the nominal size of the conduit through the entire length of each conduit.

17. All conduits shall have a polyester pull tape, as specified herein, installed for future use. Pull tape shall have permanently printed sequential measurements at one-foot increments. Wire shall not be used.

18. Provide 10' of spare length of pull tape at both ends and terminate on conduit/duct plug inside junction boxes, handholes and manholes.

C. INTUMESCENT SILICONE SEALANT

1. Seal all around the cables or conductors inside all conduits and ducts entering handholes, underground junction boxes and outdoor pad mounted equipment with intumescent silicone sealant to prevent entry of water, vermin, or debris in the conduit.

2. Use 3M Fire Barrier Packing Material PM4 or mineral wool as backing material within the conduit.

3. Install in accordance with the manufacturer's instructions.

D. CONDUIT/DUCT PLUGS

1. Install conduit/duct plug in all spare (empty) conduits/ducts as indicated on the Drawings to prevent vermin from entering electrical equipment or a building through the conduit.
2. Size plugs based on the trade size of the conduit/duct to be sealed.
3. Tie-off pull tape to eye on duct plug before inserting into conduit/duct to be sealed.
4. Install plugs in accordance with the manufacturer's directions. Plugs shall be inserted in the conduit or duct such that they fit flush with the end of the raceway. Tighten down the nut to create a water-tight seal but do not over-tighten.

E. UNDERGROUND CONDUIT WARNING TAPE

1. Unless otherwise indicated, the location of all underground electrical conduit duct banks and all directly buried conduits shall be marked by burying one or more warning tapes below grade in the backfill. The warning tape shall be placed 18 inches above the top of the conduit(s) or duct bank and shall be parallel along the full length of the run. Where the top of the conduit(s) or duct bank is less than three feet (3'-0") below finish grade the warning tape shall be placed 12 inches above the top of the conduit(s) or duct bank.
2. If the width of the conduits or duct bank is wider than 2 feet, two or more warning tapes shall be used, all in the same plane, spacing the tapes no more than 12 inches apart horizontally across the top width of the conduits or duct bank and equally spacing the tapes in from each longitudinal outer edge of the buried conduits or duct bank.
3. Contractor shall exercise care to ensure that the warning tape is properly located.

3.2 ELECTRICAL CONDUIT DUCT BANK EARTHWORK

A. Earthwork shall comply with Division 31 – Earthwork.

B. Conduit shall be adequately and properly supported on solid earth, or other indicated means, throughout the entire length of the run. All conduit shall be laid straight and true.

3.3 ELECTRICAL CONDUIT DUCT BANK CONCRETE, FORMWORK AND REINFORCEMENT

A. All concrete, formwork and reinforcement shall be in accordance with Division 03 – Concrete.

B. Concrete encased electrical conduit duct banks shall contain steel reinforcing throughout the entire length as indicated on the standard details on the Drawings.

C. The minimum size of reinforcing steel shall be size No. 4. The reinforcing steel shall be installed longitudinally, at each corner of the duct bank (in cross section) and along the top, bottom and sides at a maximum of 12 inches on center. All reinforcing steel shall have a minimum concrete cover of 1-1/2 inches. Reinforcing shall be installed latitudinally, as needed, to hold the longitudinal steel in place during placement of the concrete, but not more than 48 inches apart.

D. In no case shall duct bank sidewall thickness exceed 12 inches from the side of the duct.

E. The concrete for all 4.16 kV duct banks shall have medium red color additive. The color additive shall have a minimum concentration per manufacturer's recommendation per yard of concrete and shall be mixed throughout all of the duct bank concrete. "Sprinkling" of the color

additive on the top of the concrete and "working" in after the concrete has been poured is not acceptable.

F. Concrete shall be placed with the aid of a mechanical vibrator.

G. Underground electrical conduit duct bank excavations shall not be backfilled until concrete has cured to a minimum of 50% of rated strength, seven (7) days minimum, except for high-early-strength concrete, which shall be three (3) days minimum.

3.4 UNDERGROUND UTILITIES

A. The Contractor shall communicate with Missouri One Call, telephone 1-800-DIG-RITE (1-800-344-7483), 72 hours in advance of any underground work for locating publicly owned underground utilities.

B. Before any excavations are begun, the Contractor shall communicate with the Owner and obtain, if possible, the exact location of any privately underground structures or utilities located in the vicinity of the excavation.

C. Existing underground utilities shown on the Drawings are based on available record documents obtained from the Owner, but their accuracy is generally unconfirmed. Existing underground utilities in the areas of construction are believed to be private and therefore, will not be located by the Missouri One Call program. Obtain field utility locates from a private utility locate company prior to performing any excavation work.

D. The Contractor shall use extreme care and caution during excavation and backfilling to avoid damage to any existing underground structures and utility lines. Prior to and during excavation, the Contractor shall use every means to determine the exact location of all underground structures, electrical conduit, pipe lines, telephone cables, water lines, gas lines, sewer lines, conduit duct banks, etc., in the immediate vicinity of the excavation.

E. The Contractor shall be solely responsible for the protection, repairs, or replacement of any existing underground item which was broken or otherwise damaged by the Contractor, including any consequential damage resulting therefrom, either above or below ground.

F. All conduit, water, gas, and sewer pipes adjacent to or crossing excavations shall be properly supported and protected by the Contractor.

END OF SECTION 337119.13