

PROJECT MANUAL

*Upgrade Cave Electric
Onondaga Cave State Park
Leasburg, Missouri*

Designed By: Rogers-Schmidt Engineering Co., P.C.
1736 West Park Center Dr., Suite 204
St. Louis, MO 63026

Date Issued: June 23, 2023

Project No.: X2212-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION
Facilities Management, Design & Construction

**SECTION 000107A – PROFESSIONAL SEALS AND CERTIFICATIONS –
GENERAL AND ELECTRICAL**

PROJECT NUMBER: X2212-01 Upgrade Cave Electric
Onondaga Cave State Park
Leasburg, Missouri

THE FOLLOWING DESIGN PROFESSIONAL HAS 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:

All

Specifications:

Division 01
Division 26
Division 27



Barry D. Freiner, P.E.

END OF SECTION 000107A

SECTION 000107B – PROFESSIONAL SEALS AND CERTIFICATIONS – CIVIL AND STRUCTURAL

PROJECT NUMBER: X2212-01 Upgrade Cave Electric
Onondaga Cave State Park
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Drawings:

None

Specifications:

Division 03
Division 31
Division 32



Christopher L. Barth, P.E.

END OF SECTION 000107B

TABLE OF CONTENTS

SECTION	TITLE	NUMBER OF PAGES
DIVISION 00 – PROCUREMENT AND CONTRACTING INFORMATION		
000000 INTRODUCTORY INFORMATION		
000101	Project Manual Cover	1
000107A	Professional Seals and Certifications – General and Electrical	1
000107B	Professional Seals and Certifications – Civil and Structural	1
000110	Table of Contents	2
000115	List of Drawings	2
001116	INVITATION FOR BID (IFB) plus Missouri Buys instructions and special notice	3
002113	INSTRUCTIONS TO BIDDERS (Includes MBE/WBE/SDVE Information)	8
003144	MBE/WBE/SDVE Directory	1
The following documents may be found on MissouriBUYS at https://missouribuys.mo.gov/		
004000 PROCUREMENT FORMS & SUPPLEMENTS		
004113	Bid Form	*
004322	Unit Prices Form	*
004336	Proposed Subcontractors Form	*
004337	MBE/WBE/SDVE Compliance Evaluation Form	*
004338	MBE/WBE/SDVE Eligibility Determination Form for Joint Ventures	*
004339	MBE/WBE/SDVE Good Faith Effort (GFE) Determination Forms	*
004340	SDVE Business Form	*
004541	Affidavit of Work Authorization	*
004545	Anti-Discrimination Against Israel Act Certification form	*
005000 CONTRACTING FORMS AND SUPPLEMENTS		
005213	Construction Contract	3
005414	Affidavit for Affirmative Action	1
006000 PROJECT FORMS		
006113	Performance and Payment Bond	2
006325	Product Substitution Request	2
006519.16	Final Receipt of Payment and Release Form	1
006519.18	MBE/WBE/SDVE Progress Report	2
006519.21	Affidavit of Compliance with Prevailing Wage Law	1
007000 CONDITIONS OF THE CONTRACT		
007213	General Conditions	20
007300	Supplementary Conditions	1
007346	Wage Rate	4
DIVISION 1 - GENERAL REQUIREMENTS		
011000	Summary of Work	3
012100	Allowances	2
012200	Unit Prices	2
012300	Alternates	2
012500	Substitution Procedures	3
012600	Contract Modification Procedures	2
013100	Coordination	4
013115	Project Management Communications	4
013200	Schedule – Bar Chart	4
013300	Submittals	5
013300.10	Submittal Register	4
013513.31	Site Security and Health Requirements (DNR)	5
015000	Construction Facilities and Temporary Controls	8
016000	Product Requirements	4
017400	Cleaning	3
017823	Operation and Maintenance Data	5
017900	Demonstration and Training	6
SECTION 000110 – TABLE OF CONTENTS		
9/9/20		

TECHNICAL SPECIFICATIONS INDEX

SECTION	TITLE	NUMBER OF PAGES
DIVISION 2 - EXISTING CONDITIONS		
024119	Selective Demolition	6
DIVISION 3 - CONCRETE		
031000	Concrete Forming and Accessories	8
032000	Concrete Reinforcing	3
033000	Cast-In-Place Concrete	13
DIVISION 4 - 25		
NOT USED		
DIVISION 26 – ELECTRICAL		
260500	Common Work Results for Electrical	11
260505	Selective Demolition for Electrical	8
260519	Low-Voltage Electrical Power Conductors and Cables	7
260526	Grounding and Bonding for Electrical Systems	5
260529	Hangers and Supports for Electrical Equipment	4
260533.13	Conduit for Electrical Systems	10
260533.16	Boxes for Electrical Systems	5
260553	Identification for Electrical Systems	6
260573	Protective Device Coordination Study and Arc Flash Risk Assessment	10
260583	Wiring Connections	5
260943.23	Relay-Based Lighting Controls	9
262416	Panelboards	11
262726	Wiring Devices	3
262813	Fuses	2
262816.13	Enclosed Circuit Breakers	3
263213.13	Diesel-Engine-Driven Generator Set	28
263236	Resistive Load Banks	7
263613	Non-Automatic Transfer Switches	11
263623	Automatic Transfer Switches	11
265113	Interior Lighting Fixtures, Lamps and Drivers	5
265613	Cave Lighting Fixtures, Power Supply Units and Drivers	13
DIVISION 27 – COMMUNICATIONS		
270500	Common Work Results for Communications	8
270505	Selective Demolition for Communications	6
270526	Grounding and Bonding for Communications Systems	2
270529	Hangers and Supports for Communications Systems	2
270533.13	Conduit for Communications Systems	2
270553	Identification for Communications Systems	2
271513.13	Communications Copper Direct Buried Cabling	3
273213	Industrial Telephone Sets	3
DIVISION 28 - 30		
NOT USED		
DIVISION 31 – EARTHWORK		
310000	Earthwork	15
311000	Site Clearing	4
315000	Excavation Support and Protection	4
DIVISION 32 – EXTERIOR IMPROVEMENTS		
321413	Precast Concrete Unit Pavers	2
329219	Seeding	8
DIVISION 33 - 48		
NOT USED		

SECTION 000115 – LIST OF DRAWINGS

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 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:

	<u>TITLE</u>	<u>SHEET #</u>	<u>DATE</u>
1.	Cover Sheet	Sheet G-001	06-23-23
2.	Site Maps and Drawing Index	Sheet G-002	06-23-23
3.	Civil Site Plan	Sheet C-101	06-23-23
4.	Civil Details	Sheet C-501	06-23-23
5.	Electrical Symbols, Abbreviations & General Notes	Sheet E-001	06-23-23
6.	Above Ground Site Plan	Sheet ES-101	06-23-23
7.	Cave Site Plan	Sheet ES-102	06-23-23
8.	Enlarged Site Plan – Demolition	Sheet ES-401	06-23-23
9.	Enlarged Site Plan – New Work	Sheet ES-402	06-23-23
10.	Cave Electrical Demolition Plan - Section A	Sheet ED-101	06-23-23
11.	Cave Electrical Demolition Plan - Section B	Sheet ED-102	06-23-23
12.	Cave Electrical Demolition Plan - Section C	Sheet ED-103	06-23-23
13.	Cave Electrical Demolition Plan - Section D	Sheet ED-104	06-23-23
14.	Cave Electrical Demolition Plan - Section E	Sheet ED-105	06-23-23
15.	Cave Electrical Demolition Plan - Section F	Sheet ED-106	06-23-23
16.	Cave Electrical Demolition Plan - Section G	Sheet ED-107	06-23-23
17.	Cave Electrical Demolition Plan - Section H	Sheet ED-108	06-23-23
18.	Cave Electrical Demolition Plan - Section I	Sheet ED-109	06-23-23
19.	Cave Electrical Demolition Plan - Section J	Sheet ED-110	06-23-23
20.	Cave Electrical Demolition Plan - Section K	Sheet ED-111	06-23-23
21.	Cave Electrical Demolition Plan - Section L	Sheet ED-112	06-23-23
22.	Cave Electrical Demolition Plan - Section M	Sheet ED-113	06-23-23
23.	One-Line Diagrams (Exist Condition)	Sheet ED-601	06-23-23
24.	One-Line Airlock Service (Exist Condition)	Sheet ED-602	06-23-23
25.	One-Line MO Caverns Service (Exist Condition)	Sheet ED-603	06-23-23
26.	One-Line Submarine Room Service (Exist Condition)	Sheet ED-604	06-23-23
27.	Cave Electrical Plan - Section A	Sheet E-101	06-23-23
28.	Cave Electrical Plan - Section B	Sheet E-102	06-23-23

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

X2212-01

29.	Cave Electrical Plan - Section C	Sheet E-103	06-23-23
30.	Cave Electrical Plan - Section D	Sheet E-104	06-23-23
31.	Cave Electrical Plan - Section E	Sheet E-105	06-23-23
32.	Cave Electrical Plan - Section F	Sheet E-106	06-23-23
33.	Cave Electrical Plan - Section G	Sheet E-107	06-23-23
34.	Cave Electrical Plan - Section H	Sheet E-108	06-23-23
35.	Cave Electrical Plan - Section I	Sheet E-109	06-23-23
36.	Cave Electrical Plan - Section J	Sheet E-110	06-23-23
37.	Cave Electrical Plan - Section K	Sheet E-111	06-23-23
38.	Cave Electrical Plan - Section L	Sheet E-112	06-23-23
39.	Cave Electrical Plan - Section M	Sheet E-113	06-23-23
40.	Electrical Details	Sheet E-501	06-23-23
41.	Electrical Details	Sheet E-502	06-23-23
42.	One-Line Diagram	Sheet E-601	06-23-23
43.	One-Line Airlock Feeder	Sheet E-602	06-23-23
44.	One-Line Submarine Room Feeder	Sheet E-603	06-23-23
45.	New Panelboard Schedules	Sheet E-604	06-23-23
46.	New Lighting Fixture Schedule	Sheet E-605	06-23-23
47.	New Lighting Power Supply Unit (PSU) Schedule	Sheet E-606	06-23-23
48.	New Lighting Power Supply Unit (PSU) Schedule	Sheet E-607	06-23-23
49.	New Lighting Control Station Configurations	Sheet E-608	06-23-23
50.	One-Line Diagram – Cave Emergency Telephones	Sheet T-601	06-23-23

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 Cave Electric
Onondaga Cave State Park
Leasburg, Missouri
Project No.: X2212-01

3.0 BIDS WILL BE RECEIVED:

- A. Until: 1:30 PM, Tuesday, August 22, 2023
- B. **Only electronic bids on MissouriBUYS shall be accepted: <https://missouribuys.mo.gov>. Bidder must be registered to bid.**

4.0 DESCRIPTION:

- A. Scope: The project includes replacement of the electrical infrastructure within Onondaga Cave at Onondaga Cave State Park.
- B. MBE/WBE/SDVE Goals: MBE 10%, WBE 10%, and SDVE 3%. **NOTE: Only MBE/WBE firms certified by the State of Missouri Office of Equal Opportunity as of the date of bid opening, or SDVE(s) meeting the requirements of Section 34.074, RSMo and 1 CSR 30-5.010, can be used to satisfy the MBE/WBE/SDVE participation goals for this project.**
- C. ****NOTE:** Bidders are provided new Good Faith Effort (GFE) forms on MissouriBUYS.

5.0 PRE-BID MEETING:

- A. Place/Time: 10 AM, Monday, August, 7, 2023, at Onondaga Cave State Park Office, 7556 Highway H, Leasburg, Missouri 65535.

THIS IS A MANDATORY PRE-BID.

- 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 Co., P.C., Barry Freiner, 636-600-1551, email: bfreiner@rogers-schmidt.com
- B. Project Manager: Sandra Walther, 573-751-2283, email: sandra.walther@oa.mo.gov

8.0 GENERAL INFORMATION:

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

Very Important MissouriBUYS Instructions to Help Submit a Bid Correctly

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

IMPORTANT REMINDER REGARDING REQUIREMENT FOR OEO CERTIFICATION

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

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

SECTION 002113 – INSTRUCTIONS TO BIDDERS

1.0 - SPECIAL NOTICE TO BIDDERS

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

2.0 - BID DOCUMENTS

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

3.0 - BIDDERS' OBLIGATIONS

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

4.0 - INTERPRETATIONS

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

5.0 - BIDS AND BIDDING PROCEDURE

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

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

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

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

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

6.0 - SIGNING OF BIDS

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

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

7.0 - RECEIVING BID SUBMITTALS

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

8.0 - MODIFICATION AND WITHDRAWAL OF BIDS

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

9.0 - AWARD OF CONTRACT

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

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

10.0 - CONTRACT SECURITY

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

11.0 - LIST OF SUBCONTRACTORS

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

12.0 - WORKING DAYS

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

13.0 - AMERICAN AND MISSOURI - MADE PRODUCTS AND FIRMS

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

14.0 – ANTI-DISCRIMINATION AGAINST ISRAEL ACT CERTIFICATION:

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

15.0 - MBE/WBE/SDVE INSTRUCTIONS

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

B. MBE/WBE/SDVE General Requirements:

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

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

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

D. Certification of MBE/WBE/SDVE Subcontractors:

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

E. Waiver of MBE/WBE/SDVE Participation:

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

F. Contractor MBE/WBE/SDVE Obligations

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

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

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

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

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

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

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



State of Missouri Construction Contract

THIS AGREEMENT is made (DATE) by and between:

Contractor Name and Address

hereinafter called the "Contractor,"

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

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

ARTICLE 1. STATEMENT OF WORK

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

Project Name: **Upgrade Cave Electric
Onondaga Cave State Park
Leasburg, Missouri**

Project Number: **X2212-01**

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 completion date is **March 29, 2024**. This time includes ten (10) working days for the Contractor to receive, sign and return the contract form along with required bonding and insurance certificates. Failure of the Contractor to provide correct bonding and insurance within the ten (10) working days shall not be grounds for a time extension. Receipt of proper bonding and insurance is a condition precedent to the formation of the contract and if not timely received, may result in forfeiture of the Contractor's bid security. Work may not commence until the Owner issues a written Notice to Proceed and must commence within seven (7) working days thereafter.

ARTICLE 3. LIQUIDATED DAMAGES

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

ARTICLE 4. CONTRACT SUM

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

Base Bid: \$
Alternate No. 1: \$

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.

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

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

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

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

Total \$

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

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

ARTICLE 7. CONTRACT DOCUMENTS

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

- 1. Division 0 – Procurement and Contracting Information, including, but not limited to:
 - a. Invitation for Bid (Section 001116)
 - b. Instructions to Bidders (Section 002113)
 - c. Supplementary Instructions to Bidders (if applicable) (Section 002213)

- d. The following documents as completed and executed by the Contractor and accepted by the Owner, if applicable:
 - i. Bid Form (Section 004113)
 - ii. Unit Prices (Section 004322)
 - iii. Proposed Contractors Form (Section 004336)
 - iv. MBE, WBE, SDVE Compliance Evaluation Form(s) (Section 004337)
 - v. MBE, WBE, SDVE Eligibility Determination Form for Joint Ventures (Section 004338)
 - vi. MBE, WBE, SDVE Good Faith Effort (GFE) Determination Form (Section 004339)
 - vii. Missouri Service Disabled Veteran Business Form (Section 004340)
 - viii. Affidavit of Work Authorization (Section 004541)
 - ix. Affidavit for Affirmative Action (Section 005414)
- e. Performance and Payment Bond, completed and executed by the Contractor and surety (Section 006113)
- f. General Conditions (Section 007213)
- g. Supplementary Conditions (Section 007300)
- h. Supplementary General Conditions for Federally Funded/Assisted Construction Projects (Section 007333)
 - i. Wage Rate(s) (Section 007346)
- 2. Division 1 – General Requirements
- 3. All Drawings identified in the Project Manual
- 4. All Technical Specifications included in the Project Manual
- 5. Addenda, if applicable

ARTICLE 8 – CERTIFICATION

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

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

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

APPROVED:

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

 Contractor’s Authorized Signature

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

Corporate Secretary



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

PROJECT NUMBER

NAME

First being duly sworn on oath states: that

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

NAME

a sole proprietorship partnership
 limited liability company (LLC)

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

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

PROJECT TITLE

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

PRINT NAME & SIGNATURE

DATE

--

NOTARY INFORMATION

NOTARY PUBLIC EMBOSSER SEAL

STATE OF

COUNTY (OR CITY OF ST. LOUIS)

USE RUBBER STAMP IN CLEAR AREA BELOW

SUBSCRIBED AND SWORN BEFORE ME, THIS
DAY OF YEAR

NOTARY PUBLIC SIGNATURE

MY COMMISSION EXPIRES

NOTARY PUBLIC NAME (TYPED OR PRINTED)

SECTION 006113 - PERFORMANCE AND PAYMENT BOND FORM

KNOW ALL MEN BY THESE PRESENTS, THAT we _____

as principal, and _____

_____ as Surety, are held and firmly bound unto the

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

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

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

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

(Insert Project Title and Number)

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

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

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

AS APPLICABLE:

AN INDIVIDUAL

Name: _____

Signature: _____

A PARTNERSHIP

Name of Partner: _____

Signature of Partner: _____

Name of Partner: _____

Signature of Partner: _____

CORPORATION

Firm Name: _____

Signature of President: _____

SURETY

Surety Name: _____

Attorney-in-Fact: _____

Address of Attorney-in-Fact: _____

Telephone Number of Attorney-in-Fact: _____

Signature Attorney-in-Fact: _____

NOTE: Surety shall attach Power of Attorney



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

PROJECT NUMBER

PROJECT TITLE AND LOCATION

CHECK APPROPRIATE BOX

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

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

FROM: BIDDER/CONTRACTOR (PRINT COMPANY NAME)

TO: ARCHITECT/ENGINEER (PRINT COMPANY NAME)

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

SPECIFIED PRODUCT OR SYSTEM

SPECIFICATION SECTION NO.

SUPPORTING DATA

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

Sample Sample will be sent, if requested

QUALITY COMPARISON

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

PREVIOUS INSTALLATIONS

PROJECT	ARCHITECT/ENGINEER
LOCATION	DATE INSTALLED

SIGNIFICANT VARIATIONS FROM SPECIFIED PRODUCT

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



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

MBE/WBE/SDVE PROGRESS REPORT

Remit with **ALL** Progress and Final Payments

(Please check appropriate box) CONSULTANT CONSTRUCTION

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

PROJECT TITLE

PROJECT LOCATION

FIRM

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

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

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

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

INSTRUCTIONS FOR MBE/WBE/SDVE PROGRESS REPORT

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

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

At Initial Pay Application fill in the following:

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

For all subsequent Pay Applications fill in the following:

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



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

PROJECT NUMBER

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

State of _____ personally came and appeared _____

(NAME)

_____ of the _____

(POSITION) (NAME OF THE COMPANY)

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

(NAME OF PROJECT)

Located at _____ in _____ County

(NAME OF THE INSTITUTION)

Missouri, and completed on the _____ day of _____ 20 ____

SIGNATURE

NOTARY INFORMATION

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

FILE: Closeout Documents

GENERAL CONDITIONS

INDEX

ARTICLE:

1. General Provisions

- 1.1. Definitions
- 1.2. Drawings and Specifications
- 1.3. Compliance with Laws, Permits, Regulations and Inspections
- 1.4. Nondiscrimination in Employment
- 1.5. Anti-Kickback
- 1.6. Patents and Royalties
- 1.7. Preference for American and Missouri Products and Services
- 1.8. Communications
- 1.9. Separate Contracts and Cooperation
- 1.10. Assignment of Contract
- 1.11. Indemnification
- 1.12. Disputes and Disagreements

2. Owner/Designer Responsibilities

3. Contractor Responsibilities

- 3.1. Acceptable Substitutions
- 3.2. Submittals
- 3.3. As-Built Drawings
- 3.4. Guaranty and Warranties
- 3.5. Operation and Maintenance Manuals
- 3.6. Other Contractor Responsibilities
- 3.7. Subcontracts

4. Changes in the Work

- 4.1. Changes in the Work
- 4.2. Changes in Completion Time

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

SECTION 007213 - GENERAL CONDITIONS

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

ARTICLE 1 – GENERAL PROVISIONS

ARTICLE 1.1 - DEFINITIONS

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

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

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

ARTICLE 1.2 DRAWINGS AND SPECIFICATIONS

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

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

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

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

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

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

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

ARTICLE 1.4 - NONDISCRIMINATION IN EMPLOYMENT

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

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

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

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

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

1. A written policy statement committing the total organization to affirmative action and

assigning management responsibilities and procedures for evaluation and dissemination;

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

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

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

ARTICLE 1.5 - ANTI-KICKBACK

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

ARTICLE 1.6 - PATENTS AND ROYALTIES

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

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

ARTICLE 1.7 - PREFERENCE FOR AMERICAN AND MISSOURI PRODUCTS AND SERVICES

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

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

ARTICLE 1.8 - COMMUNICATIONS

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

ARTICLE 1.9 - SEPARATE CONTRACTS AND COOPERATION

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

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

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

ARTICLE 1.10 - ASSIGNMENT OF CONTRACT

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

ARTICLE 1.11 - INDEMNIFICATION

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

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

ARTICLE 1.12 - DISPUTES AND DISAGREEMENTS

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

ARTICLE 2 -- OWNER/DESIGNER RESPONSIBILITIES

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

for correcting such work without additional compensation.

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

ARTICLE 3 -- CONTRACTOR RESPONSIBILITIES

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

ARTICLE 3.1 -- ACCEPTABLE SUBSTITUTIONS

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

ARTICLE 3.2 -- SUBMITTALS

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

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

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

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

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

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

ARTICLE 3.3 – AS-BUILT DRAWINGS

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

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

ARTICLE 3.4 – GUARANTY AND WARRANTIES

A. General Guaranty

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

B. Extended Warranty

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

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

ARTICLE 3.5 -- OPERATION AND MAINTENANCE MANUALS

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

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

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

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

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

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

ARTICLE 3.6 – OTHER CONTRACTOR RESPONSIBILITIES

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

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

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

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

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

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

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

ARTICLE 3.7 -- SUBCONTRACTS

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

ARTICLE 4 -- CHANGES IN THE WORK

4.1 CHANGES IN THE WORK

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

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

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

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

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

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

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

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

ARTICLE 4.2 – CHANGES IN COMPLETION TIME

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

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

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

ARTICLE 5 - CONSTRUCTION AND COMPLETION

ARTICLE 5.1 – CONSTRUCTION COMMENCEMENT

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

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

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

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

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

ARTICLE 5.2 -- PROJECT CONSTRUCTION

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

ARTICLE 5.3 -- PROJECT COMPLETION

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

days notice before the inspection shall be performed.

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

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

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

ARTICLE 5.4 -- PAYMENT TO CONTRACTOR

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

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

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

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

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

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

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

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

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

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

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

ARTICLE 6 -- INSURANCE AND BONDS

ARTICLE 6.1 -- BOND

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

ARTICLE 6.2 – INSURANCE

- A. The successful Contractor shall procure and maintain for the duration of the contract issued a policy or policies of insurance for the protection of both the Contractor and the Owner and their respective officers, officials, agents, consultants and employees. The Owner requires certification of insurance coverage from the Contractor prior to commencing work.
- B. Minimum Scope and Extent of Coverage
 - 1. General Liability
Commercial General Liability, ISO coverage form number or equivalent CG 00 01 ("occurrence" basis), or I-SO coverage form number CG 00 02, or ISO equivalent.

If ISO equivalent or manuscript general liability coverage forms are used, minimum coverage will be as follows: Premises/Operations; Independent Contractors; Products/Completed Operations; personal Injury; Broad Form Property Damage including Completed Operations; Broad Form Contractual Liability Coverage to include Contractor's obligations under Article 1.11 Indemnification and any other Special Hazards required by the work of the contract.
 - 2. Automobile Liability
Business Automobile Liability Insurance, ISO Coverage form number or equivalent CA 00 01 covering automobile liability, code 1 "ANY AUTO".
 - 3. Workers' Compensation and Employer's Liability
Statutory Workers' Compensation Insurance for Missouri and standard Employer's Liability Insurance, or the authorization to self-insure for such liability from the Missouri Division of Workers' Compensation.
 - 4. Builder's Risk or Installation Floater Insurance
Insurance upon the work and all materials, equipment, supplies, temporary structures and similar items which may be incident to the performance of the work and located at or adjacent to the site, against loss or damage from fire and such other casualties as are included in extended coverage in broad "All Risk" form, including coverage for Flood and Earthquake, in an amount not less than the replacement cost of the work or this contract price, whichever is greater, with loss payable to Contractor and Owner as their respective interests may appear.

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

- C. Minimum Limits of Insurance
 - 1. General Liability
Contractor
\$2,000,000 combined single limit per occurrence for bodily injury, personal injury, and property damage
\$2,000,000 annual aggregate
 - 2. Automobile Liability
\$2,000,000 combined single limit per occurrence for bodily injury and property damage
 - 3. Workers' Compensation and Employers Liability
Workers' Compensation limits as required by applicable State Statutes (generally unlimited) and minimum of \$1,000,000 limit per accident for Employer's Liability.

General Liability and Automobile Liability insurance may be arranged under individual policies for the full limits required or by a combination of underlying policies with the balance provided by a form-following Excess or Umbrella Liability policy.
- D. Deductibles and Self-Insured Retentions
All deductibles, co-payment clauses, and self-insured retentions must be declared to and approved by the Owner. The Owner reserves the right to request the reduction or elimination of unacceptable deductibles or self-insured retentions, as they would apply to the Owner, and their respective officers, officials, agents, consultants and employees. Alternatively, the Owner may request Contractor to procure a bond guaranteeing

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

E. Other Insurance Provisions and Requirements

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

1. General Liability

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

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

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

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

2. Automobile Insurance

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

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

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

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

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

3. Workers' Compensation/Employer's Liability

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

4. All Coverages

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

F. Insurer Qualifications and Acceptability

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

G. Verification of Insurance Coverage

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

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

ARTICLE 7 – SUSPENSION OR TERMINATION OF CONTRACT

ARTICLE 7.1 - FOR SITE CONDITIONS

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

ARTICLE 7.2 - FOR CAUSE

A. Termination or Suspension for Cause:

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

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

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

ARTICLE 7.3 -- FOR CONVENIENCE

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

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

B. Upon receipt of notification, the Contractor shall:

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

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

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

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

SECTION 007300 - SUPPLEMENTARY CONDITIONS

1.0 GENERAL:

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

2.0 CONTACTS:

Designer: Barry Freiner
Rogers-Schmidt Engineering Co., P.C.
1736 West Park Center Dr., Suite 204
St. Louis, MO 63026
Telephone: 636-600-1551
Email: bfreiner@rogers-schmidt.com

Agency Contact/
Facility: Don Stier
DNR/Missouri State Parks
1659 East Elm Street
Jefferson City, MO 65101
Telephone: 573-522-9525
Email: don.dtier@dnr.mo.gov

Construction Representative: Kevin Hultberg
Division of Facilities Management, Design and Construction
10325 Business21 North
Hillsboro, MO 63050
Telephone: 636-524-8528
Email: kevin.hultberg@oa.mo.gov

Project Manager: Sandra Walther
Division of Facilities Management, Design and Construction
301 West High Street, Room 730
Jefferson City, Missouri 65101
Telephone: 573-751-2283
Email: sandra.walther@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 6 complete sets of drawings and specifications **on water resistant/tornado bond paper at no charge.**
- B. The Owner will furnish the Contractor with approximately 6 sets of explanatory or change drawings **on water resistant/tornado bond paper at no charge.**
- C. The Contractor may make copies of the documents as needed with no additional cost to the Owner.

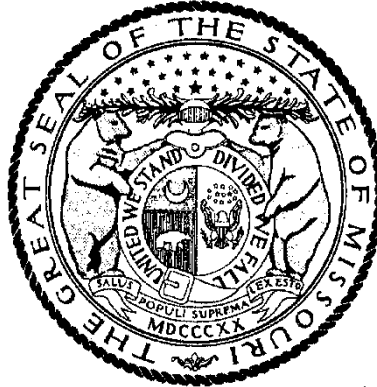
5.0 SAFETY REQUIREMENTS

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

Missouri

Division of Labor Standards

WAGE AND HOUR SECTION



MICHAEL L. PARSON, Governor

Annual Wage Order No. 30

Section 116
WEBSTER COUNTY

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

Original Signed by _____

Todd Smith, Director
Division of Labor Standards

Filed With Secretary of State: _____ **March 10, 2023**

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

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$23.77*
Boilermaker	\$23.77*
Bricklayer	\$51.67
Carpenter	\$46.72
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$23.77*
Plasterer	
Communications Technician	\$23.77*
Electrician (Inside Wireman)	\$23.77*
Electrician Outside Lineman	\$23.77*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$23.77*
Glazier	\$23.77*
Ironworker	\$23.77*
Laborer	\$41.49
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$23.77*
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$23.77*
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$23.77*
Plumber	\$50.33
Pipe Fitter	
Roofer	\$23.77*
Sheet Metal Worker	\$23.77*
Sprinkler Fitter	\$23.77*
Truck Driver	\$23.77*
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
WEBSTER County

Section 116

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$23.77*
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$23.77*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$43.28
General Laborer	
Skilled Laborer	
Operating Engineer	\$50.81
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$23.77*
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 the electrical infrastructure within Onondaga Cave at Onondaga Cave State Park.
 - 1. Project Location: 7556 Highway H, Leasburg, Missouri 65535.
 - 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 June 23, 2023, were prepared for the Project by Rogers-Schmidt Engineering Co., P.C., 1736 West Park Center Drive, Suite 204, Saint Louis, Missouri 63026.
- C. The Work consists of replacing the entire electrical power, lighting and communications systems located within Onondaga Cave.
 - 1. The Work includes, but is not limited to:
 - a. Demolition of all existing electrical power feeder conductors, panelboards, relay control panels, disconnect switches and branch circuit wiring.
 - b. Demolition of all lighting fixtures, lighting fixture shields and mounting bases, emergency lighting fixtures, lighting switches and associated electrical boxes and wiring.
 - c. Installation of new electrical service entrance equipment serving the Visitors Center and cave.
 - d. Installation of new diesel-engine generator set, non-automatic transfer switch with cam-lock connectors for temporary mobile generator connection and resistive load bank to provide emergency backup power for the Visitors Center and Onondaga Cave.
 - e. Installation of new electrical power feeder cables, panelboards and branch circuit wiring within the cave.
 - f. Installation of new LED lighting system, including lighting fixtures, power supply units, relay-based lighting controls and lighting control switching stations.
 - g. Installation of new LED strip lighting system on trail guardrails including drivers.
 - h. Installation of new emergency telephones within the cave.
- D. The Work will be executed under a single prime contract.

1.3 WORK UNDER OTHER CONTRACTS

- A. The Facility maintenance staff may be repairing the handrails along the tour trail route inside the cave at various times throughout the duration of the project.

- B. Cooperate fully with the maintenance staff so that their work may be carried out smoothly, without interfering with or delaying work under this Contract.

1.4 WORK SEQUENCE

- A. The Work will be executed under a single prime contract.
- 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.
- C. Demolition of the existing electrical distribution system in the cave is to be completed after the new electrical system is in place to the greatest extent possible.
- D. No work inside the cave may begin prior to September 16, 2023.
- E. All work, including the demolition work, shall be completed by March 29, 2024.

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

1.6 OCCUPANCY REQUIREMENTS

- A. Full Owner Occupancy: The Owner will occupy the site, existing building and cave 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 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 Contract Change.
- B. Types of allowances include the following:
 - 1. Weather allowances
- C. Related Sections include the following:
 - 1. Division 1, Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Contract Changes 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 monthly on the number of “bad weather” days to be charged against the allowance. This determination will be documented in writing and be signed by the Contractor and the Construction Representatives. If there is a failure to agree on all or part of the “bad weather” days for a particular month, that disagreement shall be noted on this written document and signed by each party’s representative. Failure of the Contractor’s representative to sign the “bad weather” day documentation after it is presented, with or without the notes of disagreement, shall constitute agreement with the “bad weather” day determination contained in that document.
- D. There will be no modification to the time of contract performance due solely to the failure to deplete the “bad weather” day allowance.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES

- A. Weather Allowance: Included within the completion period for this Project five (5) “bad weather” days.

END OF SECTION 012100

SECTION 012200 – UNIT PRICES

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. Quantities of Units to be included in the Base Bid are indicated in Section 004322 – Unit Prices Form.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Unit Prices.
- B. Related Sections include the following:
 - 1. First Division 1 Section below contains requirements that relate directly to Unit Prices.
 - 2. Division 1 Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Contract Changes.

1.3 DEFINITIONS

- A. Unit Price is an amount proposed by bidders, stated on the Bid Form Attachment 004322 as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Single Unit Price Cost: A single unit price cost shall be provided for both increasing and decreasing estimated base bid quantities; separate unit price cost for increased quantity versus decreased quantity will not be accepted.
- C. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.
- D. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- E. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. Unit Price No. 1:

1. Description: Type T lighting fixture drivers, including Stahlin PC806 NEMA 6P/IP68 polycarbonate hinged door enclosure and Stahlin BP86FG fiberglass inner back panel with two (2) nylon IP68 cable gland fittings sized as required for the Type T linear LED lighting fixture cable
2. Unit of Measurement: Each (EA)
3. Base Bid Quantity: Forty-two (42)

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Definition: An alternate is an amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the products, materials, equipment, systems, or installation methods described in the Contract Documents..
 - 1. The cost for each alternate is the net addition to the Contract Sum to incorporate the Alternate into the Work. No other adjustments are made to the Contract Sum.
- B. No additional time will be allowed for alternate work unless the number of work days is so stated on the bid form.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent Work as necessary to completely and fully integrate the Alternate Work into the Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether 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 NEMA Type 4X rated Type 304 stainless steel enclosure in lieu of NEMA Type 3R rated painted steel enclosure for the following items:

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

X2212-01

1. 400A MLO, 120/240VAC-1 Φ -3W Panelboard MDP according to Division 26 Section 262416 – Panelboards
2. 400A/2P service entrance rated enclosed main circuit breaker according to Division 26 Section 262816.13 – Enclosed Circuit Breakers
3. 230A/2P non-automatic transfer switch with cam-lock compartment according to Division 26 Section 263613 – Non-Automatic Transfer Switches
4. 400A/2P automatic transfer switch according to Division 26 Section 263623 – Automatic Transfer Switches

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 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, 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 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 Contract Change requirements.

1.3 REQUESTS FOR INFORMATION

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REFERENCED FORMS

- A. The following forms can be found on our website at <https://oa.mo.gov/facilities/vendor-links/architectengineering-forms> or <https://oa.mo.gov/facilities/vendor-links/contractor-forms>:
1. Request for Information
 2. Designer’s Supplemental Instructions
 3. Request for Proposal
 4. Contract Change
 5. Contract Change Detailed Breakdown – SAMPLES
 6. Contract Change Detailed Breakdown – General Contractor (GC)
 7. Contract Change Detailed Breakdown – Subcontractor (SUB)

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 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. Related Sections include the following:
 - 1. Division 0, Section 007213 "General Conditions", Articles 1.8.B and 1.8.C for coordinating meetings onsite.
 - 2. Division 0, Section 007213 "General Conditions", Article 5.4.H 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.
 - 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.
- B. 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.
- C. 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

D. 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 the 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 the list in the Project meeting room, in the 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 Division 0, Section 007213 "General Conditions", Articles 1.8.B and 1.8.C.

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 the performance of the Work and reconvene the conference at the earliest feasible date.
 6. Project name
 7. Name and address of Contractor
 8. Name and address of Designer
 9. RFI number including RFIs that were dropped and not submitted
 10. RFI description
 11. Date the RFI was submitted
 12. Date Designer's response was received
 13. 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, E-Builder[®] ASP software, and protocols included in that software during this project. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.
 - 1. Project management communications is available through E-Builder[®] as provided by "e-Builder[®]" in the form and manner required by the Owner.
 - 2. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited.
- B. Support: E-Builder[®] will provide on-going support through on-line help files.
- C. Copyrights and Ownership: Nothing in this specification or the subsequent communications supersedes the parties' obligations and rights for copyright or document ownership as established by the Contract Documents. The use of CAD files, processes or design information distributed in this system is intended only for the project specified herein.
- D. Purpose: The intent of using E-Builder[®] is to improve project work efforts by promoting timely initial communications and responses. Secondly, to reduce the number of paper documents while providing improved record keeping by creation of electronic document files.
- E. Authorized Users: Access to the web site will be by individuals who are authorized users.
 - 1. Individuals shall complete the E-Builder New Company/User Request Form located at the following web site: <https://oa.mo.gov/facilities/vendor-links/contractor-forms>. Completed forms shall be emailed to the following email address: OA.FMDCE-BuilderSupport@oa.mo.gov.
 - 2. Authorized users will be contacted directly and assigned a temporary user password.

3. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.
- F. Administrative Users: Administrative users have access and control of user licenses and all posted items. **DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!** Improper or abusive language toward any party or repeated posting of items intended to deceive or disrupt the work of the project will not be tolerated and will result in deletion of the offensive items and revocation of user license at the sole discretion of the Administrative User(s).
- G. Communications: The use of fax, email and courier communication for this project is discouraged in favor of using E-Builder® to send messages. Communication functions are as follows:
1. Document Integrity and Revisions:
 - a. Documents, comments, drawings and other records posted to the system shall remain for the project record. The authorship time and date shall be recorded for each document submitted to the system. Submitting a new document or record with a unique ID, authorship, and time stamp shall be the method used to make modifications or corrections.
 - b. The system shall make it easy to identify revised or superseded documents and their predecessors.
 - c. Server or Client side software enhancements during the life of the project shall not alter or restrict the content of data published by the system. System upgrades shall not affect access to older documents or software.
 2. Document Security:
 - a. The system shall provide a method for communication of documents. Documents shall allow security group assignment to respect the contractual parties communication except for Administrative Users. **DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!**
 3. Document Integration:
 - a. Documents of various types shall be logically related to one another and discoverable. For example, requests for information, daily field reports, supplemental sketches and photographs shall be capable of reference as related records.
 4. Reporting:
 - a. The system shall be capable of generating reports for work in progress, and logs for each document type. Summary reports generated by the system shall be available for team members.
 5. Notifications and Distribution:
 - a. Document distribution to project members shall be accomplished both within the extranet system and via email as appropriate. Project document distribution to parties outside of the project communication system shall be

accomplished by secure email of outgoing documents and attachments, readable by a standard email client.

6. Required Document Types:
 - a. RFI, Request for Information
 - b. Submittals, including record numbering by drawing and specification section
 - c. Transmittals, including record of documents and materials delivered in hard copy
 - d. Meeting Minutes
 - e. Application for Payments (Draft or Pencil)
 - f. Review Comments
 - g. Field Reports
 - h. Construction Photographs
 - i. Drawings
 - j. Supplemental Sketches
 - k. Schedules
 - l. Specifications
 - m. Request for Proposals
 - n. Designer's Supplemental Instructions
 - o. Punch Lists

H. Record Keeping: Except for paper documents, which require original signatures and large format documents (greater than 8½ x 11 inches), all other 8½ x 11 inches documents shall be submitted by transmission in electronic form to the E-Builder® web site by licensed users.

- a. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier shall respond to documents received in electronic form on the web site and consider them as if received in paper document form.
- b. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall reply or respond by transmissions in electronic form on the web site to documents actually received in paper document form.
- c. The Owner and his representatives, the Designer and his consultants, and the Contractor and his Sub Contractors and suppliers at every tier reserves the right to and shall copy any paper document into electronic form and make same available on the web site.

I. Minimum Equipment and Internet Connection: In addition to other requirements specified in this Section, the Owner and his representatives, the Construction Manager and his representatives, the Architect and his consultants, and the Contractor and his sub-

contractors and suppliers at every tier required to have a user license(s) shall be responsible for the following:

1. Providing suitable computer systems for each licensed user at the user's normal work location¹ 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 system² 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 E-Builder® Documents area.

SECTION 013200 – SCHEDULE – BAR CHART

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions 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.
1. The Contractor shall provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.
 - a. If practical, use the same Schedule of Values breakdown for schedule time bars.
 2. The Contractor shall provide a base activity time bar showing duration for each construction activity. Each bar is to indicate start and completion dates for the activity. The Contractor is to place a contrasting bar below each original schedule activity time for indicating actual progress and planned remaining duration for the activity.
 3. The Contractor shall prepare the Schedule on a minimal number of separate sheets to readily show the data for the entire construction period.
 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on schedule with other construction activities. Include minor elements involved in the overall sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.
 5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other required schedules and reports.
 6. Indicate the Intent to Award and the Contract Substantial Completion dates on the schedule.
- B. Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
1. Requirement for Phased completion
 2. Work by separate Contractors
 3. Work by the Owner
 4. Pre-purchased materials
 5. Coordination with existing construction
 6. Limitations of continued occupancies
 7. Un-interruptible services
 8. Partial Occupancy prior to Substantial Completion
 9. Site restrictions
 10. Provisions for future construction
 11. Seasonal variations
 12. Environmental control

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

3.3 SCHEDULE OF SUBMITTALS

- A. Upon acceptance of the Construction Progress Schedule, prepare and submit a complete schedule of submittals. Coordinate the submittal schedule with Section 013300 SUBMITTALS, the approved Construction Progress Schedule, list of subcontracts, Schedule of Values and the list of products.
- B. Prepare the schedule in chronological order. Provide the following information:
1. Scheduled date for the first submittal
 2. Related Section number
 3. Submittal category
 4. Name of the Subcontractor
 5. Description of the part of the Work covered
 6. Scheduled date for resubmittal
 7. Scheduled date for the Designer’s final release or approval
- C. Distribution: Following the Designer’s response to the initial submittal schedule, print and distribute copies to the Designer, Owner, subcontractors, and other parties required to comply with submittal dates indicated.
1. Post copies in the Project meeting room and temporary field office.
 2. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the Work and are no longer involved in construction activities.

- D. Schedule Updating: Revise the schedule after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

3.4 SCHEDULE OF INSPECTIONS AND TESTS

- A. Prepare a schedule of inspections, tests, and similar services required by the Contract Documents. Submit the schedule with (15) days of the date established for commencement of the Contract Work. The Contractor is to notify the testing agency at least (5) working days in advance of the required tests unless otherwise specified.
- B. Form: This schedule shall be in tabular form and shall include, but not be limited to, the following:
 - 1. Specification Section number
 - 2. Description of the test
 - 3. Identification of applicable standards
 - 4. Identification of test methods
 - 5. Number of tests required
 - 6. Time schedule or time span for tests
 - 7. Entity responsible for performing tests
 - 8. Requirements for taking samples
 - 9. Unique characteristics of each service
- C. Distribution: Distribute the schedule to the Owner, 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 and Division 01 Specification Sections, apply to this Section.

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 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Construction Progress Schedule including Schedule of Values
2. Performance and Payment Bonds
3. Insurance Certificates
4. Applications for Payment
5. Certified Payroll Reports
6. Partial and Final Receipt of Payment and Release Forms
7. Affidavit – Compliance with Prevailing Wage Law
8. Record Drawings
9. Notifications, Permits, etc.

- C. The Contractor is obliged and responsible to check all shop drawings and schedules to assure compliance with contract plans and specifications. The Contractor is responsible for the content of the shop drawings and coordination with other contract work. Shop drawings and schedules shall indicate, in detail, all parts of an Item or Work including erection and setting instructions and integration with the Work of other trades.

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

1.3 SUBMITTAL PROCEDURES

- A. The Contractor shall comply with the General and Supplementary Conditions and other applicable sections of the Contract Documents. The Contractor shall submit, with such promptness as to cause no delay in his work or in that of any other contractors, all required submittals indicated in Part 3.1 of this section and elsewhere in the Contract Documents. Coordinate preparation and processing of submittals with performance of construction activities.

Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
- B. Each drawing and/or series of drawings submitted must be accompanied by a letter of transmittal giving a list of the titles and numbers of the drawings. Each series shall be numbered consecutively for ready reference and each drawing shall be marked with the following information:
1. Date of Submission
 2. Name of Project
 3. Location
 4. Section Number of Specification
 5. State Project Number
 6. Name of Submitting Contractor
 7. Name of Subcontractor
 8. Indicate if Item is submitted as specified or as a substitution

1.4 SHOP DRAWINGS

- A. Comply with Division 0, Section 007213 “General Conditions”, Article 3.2 “Submittals”.
- B. The Contractor shall submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
- C. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings including the following information:
 1. Dimensions
 2. Identification of products and materials included by sheet and detail number
 3. Compliance with specified standards
 4. Notation of coordination requirements
 5. Notation of dimensions established by field measurement
 6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8½”x11” but no larger than 36”x48”.

1.5 PRODUCT DATA

- A. The Contractor shall comply with Division 0, Section 007213 “General Conditions”, Article 3.2 “Submittals”.
- 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 Division 0, Section 007213 "General Conditions", Article 3.2 "Submittals".
- 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 Division 0, Section 007213 "General Conditions", Article 3.2 "Submittals".
- 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 two (2) sets of prints, black and white, glossy; 8"x10" size; mounted on 8½"x11" soft card stock with left edge binding margin for 3-hole punch.
 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 Division 0, Section 007213 "General Conditions", Article 3.5 "Operation and Maintenance Manuals", and Division 0, Section 007300 "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

SECTION 013300.10 - SUBMITTAL REGISTER

SPEC SECTION	TITLE	CATEGORY
011000	Work Sequence Plan and Schedule Indicating Phasing of Work	Construction Schedule
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
013200	Schedules - Bar Chart - Schedule of Inspections and Tests	Construction Schedule
013200	Schedules - Bar Chart	Major Material Suppliers
013300	Submittals - Record Drawings	As-Builts
013300	Submittals - Notifications & Permits	Certification
013300	Submittals - Quality Control	Certification
013300	Submittals	Certification
013300	Submittals - Inspection & Test Reports	Certification
013300	Submittals - Construction Photographs	Certification
013300	Submittals - O&M Manuals	Operation / Maintenance Manual
013513.31	Site Security and Health Requirements (DNR) - MSDS	Product Data
013513.31	Site Security and Health Requirements (DNR) - Schedule of Proposed Shutdowns	Construction Schedule
013513.31	Site Security and Health Requirements (DNR) - List of Employees for Background Check	Certification
015000	Construction Facilities and Temporary Controls - Temporary Utilities	Test Report
015000	Construction Facilities and Temporary Controls - Temporary Utilities Schedule	Construction Schedule
016000	Product Requirements - Comparable Product Requests	Product Data
017823	Operation and Maintenance Manual Data	Operation / Maintenance Manual
017900	Demonstration and Training Instruction Program	Sample
017900	Demonstration and Training Attendance Record	Certification
017900	Demonstration and Training Evaluations	Certification
017900	Demonstration and Training Video Recordings	Certification
017900	Demonstration and Training Transcript	Certification
017900	Demonstration and Training Electronic Files	Operation / Maintenance Manual
024119	Selective Demolition	Construction Schedule
024119	Selective Demolition - Predemolition Photos	Certification
024119	Selective Demolition - Landfill Records	Certification
032000	Concrete Reinforcing	Shop Drawings
032000	Concrete Reinforcing	Product Data
032000	Concrete Reinforcing	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
260505	Selective Demolition for Electrical - Schedule of Selective Demolition Activities	Construction Schedule
260505	Selective Demolition for Electrical - Inventory of Items to be Salvaged	Shop Drawings
260505	Selective Demolition for Electrical - Predemolition Photographs	Shop Drawings
260505	Selective Demolition for Electrical - Disposal Records	Certification

SPEC SECTION	TITLE	CATEGORY
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Building Wire	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Type MC Power Cable	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Type MC Multiconductor Control Cable	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - 600-volt Type MC Cable Fittings	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - Liquidtight Flexible Cord and Power Cable Connectors	Product Data
260519	Low-Voltage Electrical Power Conductors and Cables - Test Reports	Test Report
260526	Grounding and Bonding for Electrical Systems - Grounding Conductors	Product Data
260526	Grounding and Bonding for Electrical Systems - Exothermic Welds	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Clamps	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Connectors	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Rods	Product Data
260526	Grounding and Bonding for Electrical Systems - Grounding Rod Resistance Test Report	Test Report
260529	Hangers and Supports for Electrical Equipment - Expansion Anchors	Product Data
260529	Hangers and Supports for Electrical Equipment - Concrete Screw Fasteners	Product Data
260529	Hangers and Supports for Electrical Equipment - U-Channel Supports & Accessories	Product Data
260533.13	Conduit for Electrical Systems - Each Type of Conduit	Product Data
260533.13	Conduit for Electrical Systems - Conduit Hubs	Product Data
260533.13	Conduit for Electrical Systems - Internal Conduit Sealing Bushings	Product Data
260533.13	Conduit for Electrical Systems - External Conduit Sealing Bushings or Link Seals	Product Data
260533.13	Conduit for Electrical Systems - Intumescent Silicone Sealant	Product Data
260533.13	Conduit for Electrical Systems - Conduit Bodies	Product Data
260533.13	Conduit for Electrical Systems - Conduit Mounting Clamps	Product Data
260533.13	Conduit for Electrical Systems - Fire-Stopping Materials	Product Data
260533.13	Conduit for Electrical Systems - Conduit Penetration Sealing Assemblies	Product Data
260533.13	Conduit for Electrical Systems - Protective Coating for Direct Buried Metal Conduit	Product Data
260533.13	Conduit for Electrical Systems - Underground Conduit Warning Tape	Product Data
260533.16	Boxes for Electrical Systems - Outlet and Non-Dimensioned Junction and Pull Boxes and Device Boxes	Product Data
260533.16	Boxes for Electrical Systems - Dimensioned Junction and Pull Boxes	Product Data
260533.16	Boxes for Electrical Systems - Junction Boxes for Underground Conduit	Product Data
260553	Identification for Electrical Systems - Nameplate Type Product Data	Product Data
260553	Identification for Electrical Systems - Nameplate Engraving Schedule	Shop Drawings
260553	Identification for Electrical Systems - Wire and Cable Identification Label Product Data	Product Data
260553	Identification for Electrical Systems - Conduit Marker Product Data	Product Data
260553	Identification for Electrical Systems - Arc Flash Hazard Warning Labels	Product Data
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Software IEEE 399 Compliance	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Study Specialist Qualifications	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - References for Arc Flash Studies	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Demonstrate of Capabilities	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Equipment Label Qualifications	Certification
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Single-Line Diagram	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Fault Current Study Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Coordination Study Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Equipment Evaluation Report	Shop Drawings

SECTION 013300.10 - SUBMITTAL REGISTER

SPEC SECTION	TITLE	CATEGORY
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - OCPD Settings Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Arc Flash Risk Assessment Report	Shop Drawings
260573	Protective Device Coordination Study & Arc Flash Risk Assessment - Final Report	Shop Drawings
260583	Wiring Connections - 600-Volt Connectors	Product Data
260583	Wiring Connections - 600-Volt Terminations	Product Data
260583	Wiring Connections - 600-Volt Pin Adapters	Product Data
260583	Wiring Connections - 600-Volt Splice Insulating Materials	Product Data
260583	Wiring Connections - Underground junction box and cave junction box splice waterproof sealing packs	Product Data
260943.23	Relay-Based Lighting Controls	Product Data
260943.23	Relay-Based Lighting Controls	Shop Drawings
260943.23	Relay-Based Lighting Controls	Certification
260943.23	Relay-Based Lighting Controls	Operation / Maintenance Manual
260943.23	Relay-Based Lighting Controls	As-Built
260943.23	Relay-Based Lighting Controls	Test Report
262416	Panelboards	Product Data
262416	Panelboards	Shop Drawings
262416	Panelboards	Certification
262416	Panelboards	Test Report
262416	Panelboards	Warranty
262416	Panelboards	Operation / Maintenance Manual
262726	Wiring Devices	Product Data
262813	Fuses - Each Type of Fuse	Product Data
262816.13	Enclosed Circuit Breakers	Product Data
262816.13	Enclosed Circuit Breakers	Shop Drawings
263213.13	Diesel-Engine-Driven Generator Set	Product Data
263213.13	Diesel-Engine-Driven Generator Set	Shop Drawings
263213.13	Diesel-Engine-Driven Generator Set	Certification
263213.13	Diesel-Engine-Driven Generator Set	Test Report
263213.13	Diesel-Engine-Driven Generator Set	Operation / Maintenance Manual
263213.13	Diesel-Engine-Driven Generator Set	Warranty
263236	Resistive Load Banks	Product Data
263236	Resistive Load Banks	Shop Drawings
263236	Resistive Load Banks	Operation / Maintenance Manual
263236	Resistive Load Banks	Warranty
263613	Non-Automatic Transfer Switches	Product Data
263613	Non-Automatic Transfer Switches	Shop Drawings
263613	Non-Automatic Transfer Switches	Certification
263613	Non-Automatic Transfer Switches	Test Report
263613	Non-Automatic Transfer Switches	Operation / Maintenance Manual
263613	Non-Automatic Transfer Switches	Warranty
263623	Automatic Transfer Switches	Product Data
263623	Automatic Transfer Switches	Shop Drawings
263623	Automatic Transfer Switches	Certification

SECTION 013300.10 - SUBMITTAL REGISTER

SPEC SECTION	TITLE	CATEGORY
263623	Automatic Transfer Switches	Test Report
263623	Automatic Transfer Switches	Operation / Maintenance Manual
263623	Automatic Transfer Switches	Warranty
265113	Interior Lighting Fixtures, Lamps and Drivers	Product Data
265113	Interior Lighting Fixtures, Lamps and Drivers	Operation / Maintenance Manual
265113	Interior Lighting Fixtures, Lamps and Drivers	Warranty
265113	Interior Lighting Fixtures, Lamps and Drivers	As-Builts
265613	Cave Lighting Fixtures, Power Supply Units and Drivers	Product Data
265613	Cave Lighting Fixtures, Power Supply Units and Drivers	Operation / Maintenance Manual
265613	Cave Lighting Fixtures, Power Supply Units and Drivers	Warranty
265613	Cave Lighting Fixtures, Power Supply Units and Drivers	As-Builts
270505	Selective Demolition for Communications - Schedule of Selective Demolition Activities	Construction Schedule
270505	Selective Demolition for Communications - Inventory of Items to be Salvaged	Shop Drawings
270505	Selective Demolition for Communications - Predemolition Photographs	Shop Drawings
270505	Selective Demolition for Communications - Disposal Records	Certification
270526	Grounding and Bonding for Communications Systems - Grounding Conductors	Product Data
270526	Grounding and Bonding for Communications Systems - Grounding Clamps	Product Data
270526	Grounding and Bonding for Communications Systems - Grounding Connectors	Product Data
270529	Hangers and Supports for Communications Equipment - U-Channel Supports & Accessories	Product Data
270533.13	Conduit for Communications Systems - Conduit	Product Data
270533.13	Conduit for Communications Systems - Conduit Mounting Clamps	Product Data
271513.13	Communications Copper Direct Buried Cabling	Product Data
271513.13	Communications Copper Direct Buried Cabling - Test Reports	Test Report
273213	Industrial Telephone Sets	Product Data
273213	Industrial Telephone Sets	Operation / Maintenance Manual
310000	Earthwork	Product Data
310000	Earthwork	Test Report
310000	Earthwork	Major Material Suppliers
311000	Site Clearing	Shop Drawings
311000	Site Clearing	As-Builts
315000	Excavation Support and Protection	Shop Drawings
315000	Excavation Support and Protection	Certification
315000	Excavation Support and Protection	As-Builts
321413	Precast Concrete Unit Pavers	Product Data
321413	Precast Concrete Unit Pavers	Test Report
321413	Precast Concrete Unit Pavers	Sample
329219	Seeding	Product Data
END OF SECTION 013300.10		

SECTION 013513.31 – SITE SECURITY AND HEALTH REQUIREMENTS (DNR)

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 SUBMITTALS

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 ACCESS TO THE SITE

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

3.2 FIRE PROTECTION, SAFETY, AND HEALTH CONTROLS

- A. The Contractor shall take all necessary precautions to guard against and eliminate possible fire hazards.
 - 1. Onsite burning is prohibited.
 - 2. The Contractor shall store all flammable or hazardous materials in proper containers located outside the buildings or offsite, if possible.
 - 3. The Contractor shall provide and maintain, in good order, during construction fire extinguishers as required by the National Fire Protection Association. In areas of flammable liquids, asphalt, or electrical hazards, 15-pound carbon dioxide or 20-pound dry chemical extinguishers shall be provided.
- B. The Contractor shall not obstruct streets or walks without permission from the Owner's Construction Representative and Facility Representatives.

- C. The Contractor's personnel shall not exceed the speed limit of 15 mph while at the Facility unless otherwise posted.
- D. The Contractor shall take all necessary, reasonable measures to reduce air and water pollution by any material or equipment used during construction. The Contractor shall keep volatile wastes in covered containers, and shall not dispose of volatile wastes or oils in storm or sanitary drains.
- E. The Contractor shall keep the project site neat, orderly, and in a safe condition at all times. The Contractor shall immediately remove all hazardous waste, and shall not allow rubbish to accumulate. The Contractor shall provide onsite containers for collection of rubbish and shall dispose of it at frequent intervals during the progress of the Work.
- F. Fire exits, alarm systems, and sprinkler systems shall remain fully operational at all times, unless written approval is received from the Owner's Construction Representative and the appropriate Facility Representative at least twenty-four (24) hours in advance. The Contractor shall submit a written time schedule for any proposed shutdowns.
- G. For all hazardous materials brought onsite, Material Safety Data Sheets shall be on site and readily available upon request at least a day before delivery.
- H. Alcoholic beverages or illegal substances shall not be brought upon the Facility premises. The Contractor's workers shall not be under the influence of any intoxicating substances while on the Facility premises.

3.3 REQUIREMENTS FOR EXECUTING WORK INSIDE THE CAVE

- A. The State of Missouri has the following laws in place regarding cave environments:
 - 1. 10 CSR 90-2.040(5) – Caves
 - 2. 577.073 – Damaging state park property
 - 3. 569.137 – Polluting cave or subsurface waters
 - 4. 569.135 – Unlawfully entering or defacing a cave or cavern
- B. Should environmental damage or defacement result from not adhering to the limits/requirements for construction inside Onondaga Cave or from willful negligence or criminal intent, the State has the above cave-specific laws at its discretion to bring to bear beyond debarment from the jobsite.
- C. No food or drink is allowed in the cave at any time. Plain water in personal water jugs may be permitted as an exception subject to approval by the Park Superintendent. However, disposable water bottles are prohibited.
- D. No bodily fluids are to be expelled in the cave environment; i.e., urinating, defecating, spitting, etc.
- E. No smoking, vaping, or chewing tobacco.
- F. No touching of any of the cave deposits; skin oils and soil can affect the way the deposits grow. Leather gloves, or other gloves as approved by the Park Superintendent, must be worn at all times while working inside the cave.
- G. Chest waders and hip boots must have non-felt boots and must be cleaned each day before exiting the cave.

- H. Nothing can be introduced into the lost river or the natural pools in the cave including, but not limited to, coins, metal shavings, trash, any type of construction debris, etc.
- I. Handrails/guardrails have a specific way of being taken apart. If the need arises, the park maintenance supervisor will provide instruction on the proper disassembly and reassembly of the handrails/guardrails.
- J. Contract employees are to stay in those portions of the cave germane to the project. Wandering into off trail passages is prohibited unless sanctioned by and accompanied by the park naturalist.
- K. No power tool may be used that emits excessive noise or any type of gas or fumes.
- L. Electric or battery powered tools only. Any exception must be approved by the Park Superintendent.
- M. The use of cutting torches is prohibited.
- N. All trash generated by the Contractor is to be removed on a daily basis.
- O. Construction activities that create dust require that the dust be collected with an electric or battery powered shop vac.
- P. Protect the cave deposits from construction damage by thinking ahead and developing a plan regarding the maneuvering of equipment and supplies in and out of the cave.
- Q. In the event any cave deposit is damaged by actions of the Contractor, the Park Superintendent will contact the Cave Research Foundation for consultation on a structural repair of the damaged item(s). The cost to repair the damage in accordance with those recommendations shall be borne by the Contractor.
- R. A Contractor indoctrination regarding the Article 3.3 requirements will be provided by the Park staff prior to the start of construction of the project.

3.4 DISRUPTION OF UTILITIES

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

3.5 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 013513.31

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

1.3 SUBMITTALS

- A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
- B. Implementation and Termination Schedule: Within (15) days of the date established for commencement of the Work, submit a schedule indicating implementation and termination of each temporary utility.

1.4 QUALITY ASSURANCE

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

1.5 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. If acceptable to the Designer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.
- B. Lumber and Plywood:
 - 1. For job-built temporary office, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.
 - 2. For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sized and thicknesses indicated.
 - 3. For fences and vision barriers, provide minimum 3/8” (9.5mm) thick exterior plywood.
 - 4. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8” (16mm) thick exterior plywood.
 - 5. For protection of cave deposits, provide minimum 3/4" (19mm) thick exterior grade plywood.

- C. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.
- D. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary office, shops, and shed.
- E. Paint:
 1. For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.
 2. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.
 3. For interior walls of temporary offices, provide two (2) quarts interior latex-flat wall paint.
- F. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of (15) or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.
- G. Water: Provide potable water approved by local health authorities. Personal water jugs may be used inside the cave. Disposable water containers are not allowed inside the cave.
- H. Open-Mesh Fencing: Provide open mesh, orange plastic fencing with tee-posts driven into the earth at maximum intervals of 15-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 3/4" (19mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100' (30m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.
- C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110 to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage rating.
- E. Lamps and Light Fixtures: Provide general service incandescent, compact fluorescent or LED lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixture where exposed to moisture.
- F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- G. Temporary Offices: Provide prefabricated or mobile units or similar job-built construction with lockable entrances, operable windows, and serviceable finishes. Provide heated and air-conditioned units on foundations adequate for normal loading.

- H. Temporary Toilet Units: Provide self-contained, single-occupant toilet units of the chemical, aerated re-circulation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- I. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers, or a combination of extinguishers of NFPA-recommended classes for the exposures.
 - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Engage the appropriate local utility company to install temporary service or connect to existing service. Where company provides only part of the service, provide the remainder with matching, compatible materials, and equipment. Comply with company recommendations.
 - 1. Arrange with company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
 - 2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.
 - 3. Obtain easements to bring temporary utilities to the site where the Owner’s easements cannot be used for that purpose.
 - 4. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Designer. Neither the Owner nor Designer will accept cost or use charges as a basis of claims for Contract Change.
- B. Temporary Water Service: The Owner will provide water for construction purposes from the existing building/cave system. Water within the cave is only available when Panelboard G is energized as the water pump is powered from this panel. 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:
 - 1. The Owner will provide electric power for construction lighting and power tools during the time the existing utility service to the Visitors Center and cave remains in service. Contractors using such services shall pay all costs of temporary services, circuits, outlet, extensions, etc.

2. The Contractor must make provisions for electric service for construction needs for the time period between when the existing utility service is disconnected, for replacement of the main electrical service equipment, until utility service is reconnected to the new main electrical service equipment. If temporary electric is obtained from Crawford Electric, the Contractor shall provide a temporary electric service installation that is acceptable to Crawford Electric and shall pay all costs for the temporary electric service directly to Crawford Electric. All temporary electric equipment shall be removed once the new permanent service is energized.
- D. Temporary Lighting: Provide temporary lighting with local switching as needed inside the cave during construction.
1. Provide temporary lighting that will provide adequate illumination for construction operations but that will not be detrimental to the cave ecosystem as directed by the Park Naturalist.
- E. 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.
- F. Temporary Telephones: Provide Superintendent cell phone number to the Construction Representative to serve as Contractor's jobsite telephone.
- G. Temporary Toilets: Install self-contained toilet units. Use of pit-type privies will not be permitted. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project's needs.
1. Shield toilets to ensure privacy.
 2. Provide separate facilities for male and female personnel.
 3. Provide toilet tissue materials for each facility.
- H. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a health and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
1. Provide paper towels or similar disposable materials for each facility.
 2. Provide covered waste containers for used material.
- I. Drinking-Water Facilities: Provide containerized, tap-dispenser, bottled-water drinking-water units, including paper supply.
1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45°F to 55°F (7°C to 13°C).
- J. Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Locate field offices, storage sheds, and other temporary construction and support facilities for easy access.

1. Maintain support facilities until near Substantial Completion. Remove prior to Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.
- B. Field Offices: Provide insulated, weathertight temporary offices of sufficient size to accommodate required office personnel at the Project site. Keep the office clean and orderly for use for small progress meetings. Furnish and equip office as follows:
1. Furnish with a desk and chairs, a 4-drawer file cabinet, plan table, plan rack, and a 6-shelf bookcase.
 2. Equip with a water cooler and private toilet complete with water closet, lavatory, and medicine cabinet unit with a mirror.
- C. Storage Facilities: Limited areas for storage of building materials are available onsite. 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.
- D. Construction Parking: Parking at the site will be provided in the areas designated at the Pre-Construction Meeting.
- E. 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 02 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations, and construction free of water.
- F. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities.
1. Install tarpaulins securely with incombustible wood framing and other materials. Close openings of 25SqFt (2.3SqM) or less with plywood or similar materials.
 2. Protect the walls, display cases and floors in the in the Visitors Center construction entrance as indicated on the Drawings.
 3. Where temporary wood or plywood enclosure exceeds 100SqFt (9.2SqM) in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.
- G. Project Identification and Temporary Signs: Prepare project identification and other signs of size indicated. Install signs where indicated to inform the public and persons seeking entrance to the Project. Support on posts or framing of preservative-treated wood or steel. Do not permit installation of unauthorized signs.
1. Project Identification Signs: Engage an experienced sign painter to apply graphics. Comply with details indicated.
 2. Temporary Signs: Prepare signs to provide directional information to construction personnel and visitors.
- H. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.
- I. 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. 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: 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.
 - 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.
 - 4. Provide supervision of welding operations and similar sources of fire ignition.
 - 5. Smoking is prohibited anywhere on the project site.
- 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: Before excavation begins, install an enclosure fence. Locate where indicated or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.
 - 1. Provide open mesh, orange plastic fencing with tee-posts driven into the earth at maximum intervals of 15-feet on center.
 - 2. Storage: Where materials and equipment must be stored and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
- 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. The Owner reserves the right to take possession of project identification signs.
 2. At Substantial Completion, clean and renovate permanent facilities used during the construction period including, but not limited to, the following:
 - a. Replace significantly worn parts and parts subject to unusual operating conditions.
 - b. 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 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 a 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, the 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 the 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. 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 the Contractor's convenience will not be considered unless otherwise indicated.

2. 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 the Contractor's convenience will not be considered unless otherwise indicated.

3. 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 and 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.
- B. No solvents or chemicals of any kind are permitted inside the cave.

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

- A. General
 - 1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage, or traffic, and providing the required protection of materials.
 - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
 - 3. At least twice each month, and more often if necessary, completely remove all scrap, debris, and waste material from the jobsite.
 - 4. Provide adequate storage for all items awaiting removal from the jobsite, observing all requirements for fire protection and protection of the ecology.
- B. Site
 - 1. Daily, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, inspect all arrangements of materials stored onsite. Re-stack, tidy, or otherwise service all material arrangements.
3. Maintain the site in a neat and orderly condition at all times.

C. Structures

1. Daily, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
2. Weekly, sweep all interior spaces clean. "Clean" for the purposes of this paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and handheld broom.
3. In preparation for installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.

3.2 FINAL CLEANING

- A. General: Provide final cleaning operations when indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of Work to the condition expected from a commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
- B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or a portion of the Project.
 1. Clean the Project Site, yard, and grounds, in areas disturbed by construction activities including landscape development areas, of rubbish, waste material, litter, and foreign substances.
 2. Sweep paved areas broom clean. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 3. Remove petrochemical spills, stains, and other foreign deposits.
 4. Remove tools, construction equipment, machinery, and surplus material from the site.
 5. Remove snow and ice to provide safe access to the building.
 6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 8. Broom clean concrete floors in unoccupied spaces.
 9. Vacuum clean carpet and similar soft surfaces removing debris and excess nap. Shampoo, if required.
 10. Clean transparent material, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 11. Remove labels that are not permanent labels.
 12. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

13. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 14. Clean plumbing fixtures to a sanitary condition free of stains, including stains resulting from water exposure.
 15. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 16. Clean ducts, blowers, and coils if units were operated without filters during construction.
 17. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out lamp modules and defective drivers in LED fixtures.
 18. 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 26 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 26 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. Submit on digital media acceptable to Designer.
 - 2. For Final Submission:
 - a. PDF Electronic File
 - 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.

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in Division 0 through 26 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 on compact disc.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

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

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

DEMONSTRATION AND TRAINING

X2212-01

017900 - 6

SECTION 024119 – SELECTIVE DEMOLITION

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. 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 260505 – Selective Demolition for Electrical
- B. Section 270505 – Selective Demolition for Communications

1.4 SUBMITTALS

- A. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and indicate proposed locations and construction of barriers.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
 - 4. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Demolition Plans: Drawings indicating the following:
 - 1. Locations of temporary protection and means of egress.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. 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.
- F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.5 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

- B. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- C. 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.
- D. Demolish: Completely remove and legally dispose of off-site.
- E. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.
- 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 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.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI A10.6 and NFPA 241, latest editions.

1.8 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 1. Inspect and discuss condition of construction to be selectively demolished.
 2. Review structural load limitations of existing structure.
 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 5. Review areas where existing construction is to remain and requires protection.

1.9 PROJECT CONDITIONS

- A. Building will be occupied during construction. Localized areas to be demolished will be vacated during demolition work.
- B. Offices and corridors immediately adjacent to demolition areas will be occupied. Conduct demolition so that access to and between occupied areas will be maintained.
- C. Hazardous Materials: If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Designer and Construction Representative.
- D. On-site storage or sale of removed items or materials is not permitted.

1.10 COORDINATION

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations and operations of adjacent occupied buildings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- 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 the most recent editions of ANSI A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION & RECORDING OF CONDITIONS

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey existing conditions and coordinate and identify the extent of the demolition work required. Record existing conditions using preconstruction photographs.
- D. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document conditions.
- E. 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 Construction Representative and Designer.
- F. Engage a professional engineer to perform an engineering survey of 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.
- G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 COORDINATION

- A. No demolition work shall be performed without prior approval of the Construction 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 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 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 Designer.
- 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 Construction Representative. Any such material removed without permission 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 damage 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 demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Existing building openings shall be used to remove demolished material. No new openings may be made without approval of the Construction Representative.

3.4 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
 - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
 - a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
- C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 1, Section 015000 "Construction Facilities and Temporary Controls."
 - 1. Protect adjacent buildings and facilities from damage due to demolition activities.
 - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

4. Provide protection to ensure safe passage of people around demolition area and to and from occupied spaces.
 5. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to demolition operations.
 6. Remove temporary barriers and protections where hazards no longer exist.
- D. 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 or modified.
1. Strengthen or add new supports when required during progress of selective demolition.
 2. Remove temporary shoring, bracing and structural supports when no longer required.

3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. All dust and slurry from concrete drilling and cutting inside the cave must be captured and removed from the cave. Under no circumstance shall any foreign material or demolition debris be allowed to enter any waterways or pools of water inside the cave.
 5. The use of cutting torches is prohibited.
 6. No power tool may be used that emits excessive noise or any type of gas or fumes.
 7. Electric or battery powered tools only. Any exception must be approved by the Park Superintendent.
 8. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Items include wall-hung cabinets and floor-standing casework where indicated on the drawings. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Designer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 REPAIRS

- A. Promptly repair damage caused by demolition operations.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

- B. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.8 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

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

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

X2212-01

- 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, as specified in Section 031505.

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. Soffits of all beam forms shall be constructed of material a minimum of 2 inches thick.
 - 3. Distribute 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. Screenshot 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 Construction 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 de-icing 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 Construction 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 Designer.
- 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 Construction 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 – Microscopical 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, coloring dye, etc.
- B. Color samples for concrete coloring dye.
- C. Manufacturer’s Installation Instructions: Submit installation procedures and interface required with adjacent work.
- D. Shop drawings for inserts.
- E. 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).
- F. 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.
- G. 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.
- H. 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.
- I. 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 Construction 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
- F. Color additive: Solomon Grind-Chem Service, Inc. with a minimum concentration of 2 lbs per sack of cement, Davis Colors with a minimum concentration of 3 lbs per sack of cement, or Scofield with a minimum concentration of 2 lbs per sack of cement or approved equal. Submit color samples for Owner selection of best color to blend in with the cave floor.

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 Construction 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 Construction 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 not 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. Color additive shall be mixed throughout all concrete used inside the cave before it is poured into place. Do not add color additive to concrete after it has been poured into the formed area.
- C. 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 Construction 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 Construction Representative.
- D. 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 Construction 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 Construction 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 Construction 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. Float Finish: Apply a float finish to all roof slabs.
 - 3. 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 Construction 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 (1) 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 Construction 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 Construction 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 Construction Representative, Designer, 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 Construction 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 Construction 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 Construction Representative to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Construction 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 Construction Representative.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Construction Representative for each individual area. Repairs made shall be in accordance with ACI 301.

3.16 SCHEDULE - CONCRETE TYPES AND TEST REQUIREMENTS

Concrete shall be Class A as specified below.

Table 1 – Concrete Proportioning and Testing Requirements

Concrete Class	A
Materials and Proportions	
Cement, ASTM C 150	Type I/II
Supplementary Cementitious Materials, <i>cm</i>	50% max [†]
Maximum Aggregate Size	3/4 inch

Water-cementitious materials ratio, <i>w/cm</i>	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% to 8%
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 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 3 – Concrete

1.4 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 Construction Representative'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 Construction Representative. 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 Construction Representative.

- 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.

1.5 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. Natural Resource: Onondaga Cave
- D. 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.
- E. 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.
- F. 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.

1.6 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 operating instructions and maintenance manuals in accordance with Section 013300 – Submittals, Section 007213 – General Conditions and 007300 – Supplementary Conditions.

1.7 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 Construction 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 Construction Representative.

1.8 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.	AEIC	Association of Edison Illuminating Companies
3.	AHDGA	American Hot Dip Galvanizers Association, Inc.
4.	AISC	American Institute of Steel Construction
5.	ANSI	American National Standards Institute
6.	ASA	American Standards Association
7.	ASTM	American Society for Testing & Materials
8.	BOCA	Building Officials and Code Administrators International, Inc.
9.	CBM	Certified Ballast Manufacturer's Association
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 Engineers
22.	IESNA	Illuminating Engineering Society of North America
23.	IFC	International Fire Code
24.	ISA	The Instrumentation, Systems, and Automation Society
25.	ISO	International Standards Organization
26.	JIC	Joint Industrial Council
27.	NBFU	National Board of Fire Underwriters
28.	NEC	National Electrical Code (NFPA 70)
29.	NECA	National Electrical Contractors Association
30.	NEMA	National Electrical Manufacturers Association
31.	NETA	InterNational Electrical Testing Association
32.	NFPA	National Fire Protection Association
33.	NIST	National Institute of Standards and Technology (formerly National Bureau of Standards, NBS)
34.	OSHA	Occupational Safety and Health Administration
35.	UL	Underwriters' Laboratories, Inc.

1.9 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 2020 edition of the National Electrical Code (NEC) NFPA-70.
- C. The Contractor shall keep a copy of the 2020 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.

1.10 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 damage the natural resource. Coordinate work to avoid any negative impact to the natural resource.
- C. Drawings are based on equipment specified. Make adjustments, modifications, or changes required, due to use of other equipment.

1.11 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 Construction 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, panelboards, enclosed switches, variable-frequency motor controllers, electrical enclosures, 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.

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 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.

2.4 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. Demolition of existing power and branch circuit conductors, cables, raceways, boxes, and equipment
 - 2. Disconnection, handling, relocation and/or reconnection of existing equipment and electric power and rerouting of existing circuits and feeders as required and as shown on the Drawings
 - 3. Removal and disposal off site of the existing equipment and materials to be removed
 - 4. All feeder and branch circuit wiring and raceways
 - 5. Grounding and bonding
 - 6. Junction and pull boxes
 - 7. Protective device coordination study and arc flash risk assessment
 - 8. Cave lighting controls
 - 9. Panelboards
 - 10. Wiring devices and cover plates
 - 11. Fuses and circuit breakers
 - 12. Enclosed circuit breakers
 - 13. Diesel-engine-driven generator set
 - 14. Resistive load bank
 - 15. Non-automatic transfer switch with cam-lock connectors
 - 16. Automatic transfer switch
 - 17. Interior lighting fixtures, lamps and drivers
 - 18. Cave lighting fixtures, power supply units and drivers

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 Construction 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 Construction Representative.

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 Construction 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 Construction 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 Construction 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 024119 – Selective Demolition and 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 floor/work platform to the horizontal centerline of the item.

<u>Item</u>	<u>Mounting Height</u>
1. Lighting control switch stations	3 feet 0 inches
2. GFCI receptacles located outdoors	2 feet 0 inches
3. GFCI receptacles located in the cave	As indicated on the Drawings

- C. The following item mounting heights shall be above finish floor/work platform to the top of the item.

<u>Item</u>	<u>Mounting Height</u>
1. Enclosed Circuit Breakers	
a. 200-400A	6 feet 0 inches
2. Exterior Panelboards	
a. 70” high or less	6 feet 0 inches
3. Power/Control Panels in Cave	
a. 48” high or less	5 feet 6 inches
4. Non-Automatic Transfer Switches	
a. 200-400A	6 feet 0 inches
5. Automatic Transfer Switches	
a. 200-400A	6 feet 0 inches

- D. Any item containing a disconnect switch or circuit breaker that is used as a switch shall be mounted in such a way as for the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 6 feet, 7 inches above the floor or working platform, including the height of the housekeeping pad if one is installed.

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 Construction 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 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Concrete equipment pads shall be provided for all outdoor, grade-mounted equipment in accordance with Section 033000 – Cast-In-Place Concrete.
- 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 3 of these Specifications.
- D. Unless otherwise indicated, outdoor equipment pads shall be 4 inches larger all around than the equipment base. Equipment pads shall have a 1-inch chamfer all around the top edge.
- E. Equipment pads shall be poured level and shall have a smooth finish.
- F. Equipment pads shall have steel reinforcing and shall be doweled to the floor slab in accordance with the requirements of Section 032000 – Concrete Reinforcing.
- G. Unless otherwise indicated, all equipment shall be properly anchored to the equipment pad using an approved means of fastening, meeting all seismic requirements of the latest edition of the International Building Code.
- H. Anchor bolts shall be provided where necessary and shall be Type 304 stainless steel or hot-dipped galvanized steel. Installation of anchor bolts shall be in accordance with Section 260529 – Hangers and Supports for Electrical Systems.

3.9 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 requirements.

3.10 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 Construction 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 Construction Representative'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. All tests shall be made after notification to and in the presence of the Construction Representative and/or Designer and the authorities having jurisdiction, if required.

C. The cost of labor, materials, instruments and supplies of any kind required for testing shall be borne by the Contractor.

D. 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.

E. Test runs shall be made over the full design load range where possible, or simulated to the satisfaction of the Construction 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.

F. 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.

G. 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 Construction Representative at no cost to the Owner.

3.11 START UP

- A. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Construction 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. 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 Construction Representative.
- D. 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 Construction Representative.

3.12 TEMPORARY POWER

- A. Adequate lighting shall be maintained in the areas of construction at all times. The Contractor shall provide, maintain, and remove temporary lighting, minimum of one (1) 100 W incandescent lamp equivalent for every 100 square feet as required.
- B. Obtain temporary power from source designated by Construction Representative. Provide load center with 120 VAC, 20A ground fault circuit interrupter receptacles if/as required.
- C. All temporary power and lighting shall be in compliance with the NEC and applicable OSHA regulations and shall be maintained and removed by the Contractor when no longer required.

END OF SECTION 260500

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 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.

1.3 RELATED SECTIONS

- A. Section 024119 – Selective Demolition
- B. Section 260500 – Common Work Results for Electrical

1.4 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.

1.5 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.

1.6 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.

1.7 PROJECT CONDITIONS

- A. Owner will occupy building 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. Hazardous Materials: Hazardous materials may be present in the interior of the building to be selectively demolished.
1. If materials suspected of containing hazardous materials are encountered, do not disturb: immediately notify Designer and Construction Representative.
 2. Hazardous material remediation will be completed as a portion of this contract. This work is anticipated to be sequenced with the proposed phasing of construction activities.
- E. On-site storage or sale of removed items or materials is not permitted.
- F. Utility Service: Maintain electrical service to building 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.

1.8 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.

1.9 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.

1.10 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 Construction Representative 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 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 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.

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. Neatly cut openings and holes plumb, square and true to dimensions, required.
- E. Use cutting methods least likely to damage construction to remain or adjoining construction.
- F. 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.
- G. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
- H. The use of cutting torches is prohibited.
- I. No power tool may be used that emits excessive noise or any type of gas or fumes.
- J. Electric or battery powered tools only. Any exception must be approved by the Park Superintendent.
- K. 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.
- L. 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.
- M. Locate selective electrical demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

- N. 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, 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 that maintain the NEMA rating of the box or enclosure.

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.

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, has identified hazardous materials such as friable asbestos or lead in the work areas.
- B. Should the Contractor discover additional 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 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. 600-volt building wire
 - 2. 600-volt PVC jacketed Type MC power cable
 - 3. 600-volt PVC jacketed Type MC multiconductor control cable
 - 4. 600-volt PVC jacketed Type MC cable fittings
 - 5. Liquidtight flexible cord and power cable connectors
- 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 90°C 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.

2.2 600-VOLT BUILDING WIRE

- A. All conductors installed in conduit, including equipment grounding conductors and single conductor control wiring, shall be copper, 600-volt, single conductor building wire.
 - 1. Conductor: ASTM B3 and ASTM B8, Class B stranded annealed copper, size 12 AWG minimum unless size 14 AWG is specifically called for on the Drawings
 - 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, date of manufacture and color per NEC Article 310-110 – Conductor Identification and Section 260553 – Identification for Electrical Systems.
 - 8. Manufacturer: General Cable Company, Prysmian Cable Company, Service Wire Company or approved equal
- B. Leads to lighting fixtures and other 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.

2.3 600-VOLT METAL-CLAD POWER CABLE: TYPE MC

- A. All conductors for lighting and power systems, installed inside the cave, shall be copper, 600-volt, PVC jacketed, armored, Type MC multiconductor cable.
 - 1. Metal-clad cable assemblies for power feeders and branch circuits shall consist of 1 or more phase conductors (as required), one neutral conductor, and one or more equipment ground conductors and shall meet the requirements of Article 330 of the NEC, ICEA S-95-658/NEMA WC-70 and ANSI/UL 1569, Standard for Metal-Clad Cables.
 - 2. Conductors: ASTM B3 and ASTM B8, Class B stranded annealed copper conductor, size 12 AWG minimum
 - 3. Insulation: Conductor insulation shall be 600-volt, Type XHHW-2, 90°C wet or dry, thickness per standard. Insulation color of conductors for application on 120/240V power systems shall be: black and red for phase conductors; white for neutral conductor and green or bare for equipment grounding conductor(s).
 - 4. Armor: Galvanized steel interlocked armor (GSIA)
 - 5. Jacket: Flame-retardant, moisture- and sunlight-resistant Polyvinyl Chloride (PVC), black, thickness per standard

6. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-95-658/NEMA WC70 and UL 1569, and IEEE 383 for flame test compliance.
7. Identification: Surface printing on the cable jacket shall show manufacturer's name, cable Type MC, number of conductors and conductor size and metal, conductor insulation type, equipment grounding conductor size and metal, voltage rating, UL symbol, and date of manufacture.
8. Manufacturer: General Cable Company, Okonite, Service Wire Company or approved equal

B. Fittings for PVC Jacketed Type MC Cable:

1. UL listed and identified for such use with PVC jacketed, metal-clad continuous corrugated sheath cable
2. Connectors shall be of stainless steel or galvanized malleable iron and shall be a compression type connector with a locknut for PVC jacketed metal clad cable.

2.4 600-VOLT METAL-CLAD MULTI-CONDUCTOR CONTROL CABLE: TYPE MC

A. All conductors for lighting control circuits, installed inside the cave, shall be copper, 600-volt, PVC jacketed, armored, Type MC multiconductor cable.

1. Metal-clad cable assemblies for control circuits shall consist of 2 or more conductors (as required) and shall meet the requirements of Article 330 of the NEC, ICEA S-95-658/NEMA WC-70 and ANSI/UL 1569, Standard for Metal-Clad Cables.
2. Conductors: ASTM B3 and ASTM B8, Class B stranded annealed copper conductor, size 14 AWG minimum
3. Insulation: Conductor insulation shall be 600-volt, Type XHHW-2, 90°C wet or dry, thickness per standard. Color-coded per ICEA Method 1, Table E-2 (does not include white or green).
4. Armor: Galvanized steel interlocked armor (GSIA) or highly flexible, continuously corrugated, welded stainless steel armor.
5. Jacket: Flame-retardant, moisture- and sunlight-resistant Polyvinyl Chloride (PVC), black, thickness per standard
6. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-95-658/NEMA WC70 and UL 1569, and IEEE 1202 for flame retardancy
7. Identification: Surface printing on the cable jacket shall show manufacturer's name, cable Type MC, number of conductors and conductor size and metal, conductor insulation type, voltage rating, UL symbol, and date of manufacture.
8. Manufacturer: Dekoron, General Cable Company, Okonite, Service Wire Company or approved equal.

2.5 600-VOLT PVC JACKETED TYPE MC CABLE FITTINGS

- A. Liquid-tight type, UL listed and identified for such use with PVC jacketed Type MC cable.
- B. Connectors shall be stainless steel for cables with stainless steel armor and zinc plated steel or galvanized malleable iron for cables with galvanized steel armor and shall be a compression type connector with a locknut.
- C. Provide PVC coated fittings if available from the factory as a UL listed product.

2.6 LIQUIDTIGHT FLEXIBLE CORD AND POWER CABLE CONNECTORS

- A. Utilize to connect flexible cord to a box, enclosure, or rigid metal conduit to provide a liquid tight strain relief connection.
 - 1. Two-piece internal design with nylon gripper and neoprene grommet
 - 2. PVC or Buna-N sealing ring and stainless-steel locknut
 - 3. UL Listed 90°C
 - 4. Stainless-steel body and gland nut
 - 5. Select for proper fit based on cord diameter
 - 6. O-Z/Gedney Type CGA, Crouse-Hinds Type CGB, Hubbell Type SHC or approved equal

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/M². 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-Volatile 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, except where indicated on the Drawings to compensate for voltage drop or for taps to cave panelboards. Submit all proposed splice locations to the Designer for approval prior to installing 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, except for PVC jacketed Type MC cables installed inside the cave.
- 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 outside diameter for 600-volt single conductor wire
 - 2. Greater than eight (8) times the cable outside diameter for 600-volt PVC jacketed Type MC 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 branch circuit.
- L. Neatly train and lace wiring inside boxes, panelboards, automatic transfer switches and equipment enclosures. Provide supplemental structural members and materials as required to support wire and cable without transmitting strain to connection points. Wire and cable shall be supported at 2-foot intervals as a minimum.

- M. Group and tie single conductors of a circuit together at a minimum of 2-foot intervals in boxes, panelboards, and automatic transfer switches.
- N. 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.
- O. Do not install conductors or cables in conduit which contains wiring already in place.
- P. Do not exceed NEC limits on conduit fill.
- Q. Conductors terminating in outlet or device boxes shall have at least 8 inches of free conductor left inside the box.
- R. All lighting system branch circuit home runs over 75 feet in length shall be size 10 AWG (minimum) unless otherwise indicated on the Drawings.
- S. Conductors for lighting and 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.
- T. Leads to lighting fixtures and 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 PVC JACKETED METAL-CLAD CABLE INSTALLATION

- A. PVC jacketed Type MC cable shall be utilized for all lighting, power and control circuits inside the cave.
- B. Bends in PVC jacketed Type MC cable shall be made so that the cable will not be damaged. The radius of the curve of the inner edge of a bend shall not be less than 8 times the overall diameter of the cable.
- C. UL Listed liquid-tight fittings shall be used for connecting PVC jacketed Type MC cable to electrical enclosures and junction and pull boxes. If UL listed PVC coated fittings are not available, provide cold shrink tube or tape wrap the fitting with two (2) half-lapped layers of 3M 130C or 2228 rubber tape overwrapped with three (3) half-lapped layers of 3M Scotch 33+ vinyl tape. Extend cold shrink tubing or tape wrapping 2" beyond the fitting onto the PVC jacketed Type MC cable.
- D. Cable preparation for installation of fittings shall follow manufacturer's instructions. The manufacturer's specialized tools shall be used for preparing cable ends for installation of fittings.
- E. The cable end shall be cut square to ensure flush seating of the cable into the fitting. Fitting gland nut shall be properly torqued.
- F. Provide a threaded galvanized steel insulated grounding bushing on connectors for PVC jacketed Type MC cable. Bond the grounding bushing to the equipment ground bus, or to the enclosure itself where there is no equipment ground bus, in accordance with Section 260526 - Bonding and Grounding for Electrical Systems.
- G. PVC jacketed Type MC cables shall be routed on the surface of the cave floor in such a fashion as to use cave features, such as break down rocks, to conceal the cables to the greatest extent possible. This will require that the cable not be routed in a straight line between source and destination. Do not disturb the cave by trenching the floor or cutting through rock. Verify routing of cables with the

Construction Representative and Park Naturalist before proceeding with the installation. Push cables into the mud for entry into lighting control station mounting posts as indicated in on the Drawings.

3.3 WIRING SEGREGATION

- A. Isolate and segregate power wiring circuits from control wiring circuits in conduit runs, boxes, panels, and equipment.
- B. Isolate and segregate "normal" power circuits from "emergency" power circuits in conduit runs, boxes, panels, and equipment.
- C. Isolate and segregate lighting and convenience receptacle wiring circuits from power and control wiring circuits in conduit and boxes.
- D. In boxes, provide isolation and segregation by rigid conduit chase through box interior or continuous metal dividers of same material as the box.

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 signoffs
 - 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. Torque test conductor connections and terminations to manufacturer's recommended values.
- D. Perform continuity tests.
- E. 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.
- F. 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 260553 – Identification for Electrical Systems
- F. Section 260583 – Wiring Connections
- G. Section 260943.23 – Relay-Based Lighting Controls
- H. Section 262416 – Panelboards
- I. Section 262726 – Wiring Devices
- J. Section 262816.13 – Enclosed Circuit Breakers
- K. Section 263213.13 – Diesel-Engine-Driven Generator Set
- L. Section 263236 – Resistive Load Banks
- M. Section 263613 – Non-Automatic Transfer Switches
- N. Section 263623 – Automatic Transfer Switches
- O. Section 265113 – Interior Lighting Fixtures, Lamps and Drivers
- P. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

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 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 two 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. Split-bolt connectors shall be copper. Use products by Blackburn, Burndy Corp., O-Z/Gedney, Penn-Union or approved equal.
- B. Split-bolts 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.

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. Install grounding conductors using as few joints as possible.
- 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. Install individual grounding conductors so as not to be entirely encircled or closely encircled by magnetic material.
- G. Suitably protect grounding conductors against damage during construction. Replace or suitably repair at the discretion of the Designer or Construction Representative if cable is damaged by anyone before final acceptance.
- 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 a bonding jumper installed between each grounding conductor and the bushing.
- I. Route exposed grounding conductors as indicated on the Drawings. Route along the webs of columns and beams, and in corners where possible for maximum physical protection. Support with one-hole steel strap, tack welded to structural member a minimum of every 4 feet.
- J. All neutral conductors shall be continuous throughout the electrical system and shall be grounded only where indicated on the Drawings or as specified herein.
- K. All metallic conduits shall be properly grounded.
- L. All flexible conduits shall contain a properly connected green insulated copper grounding conductor, sized in accordance with National Electrical Code, 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 and toggle switches 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 enclosures, panels, boxes, equipment frames, conduits, equipment frames and other non-current-carrying metallic objects shall be grounded and bonded as required by the NEC.
- R. Exothermically welded electrical connections to painted structural steel shall be covered with a minimum of one coat of paint having color to match that of the structural steel.
- S. Connections: All grounding conductor connections shall be made in accordance with the manufacturer's written instructions. Chemically degrease and dry completely before 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.
- T. Grounding conductors and bonding jumper connection devices or fittings that depend on solder shall not be used.
- U. 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.
- V. Bond all metal conduits to the ground bus bar conductor of the control panel, terminal box, panelboard, non-automatic transfer switch, automatic transfer switch or frame of the equipment to which they are connected by terminating each conduit with a threaded galvanized steel insulated grounding bushing or insulated throat, grounding type conduit hub having a solderless lug with a bonding jumper sized in accordance with NEC Table 250-66 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 mechanical lug. Scrape away paint at grounding lug attachment location.
- W. All control panel, panelboard, 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 as indicated on the Drawings.
- X. Power system neutrals shall be grounded only at the transformer where each system neutral is derived in accordance with NEC Article 250.
- Y. 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 RACEWAY SYSTEM GROUNDING

- A. Ground/bond metallic conduits at all termination points.
- B. Where extending metallic conduit into floor or grade mounted equipment from below, provide a threaded galvanized steel 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
(262) 309-3440
Brad Gilmer
 - 3. Frank Sager & Son, Inc.
4754 Theiss Road
St. Louis, MO 63128-2349
Mark Rodgers
(314) 892-7550
 - 4. Schneider Electric Services
1101 Jefferson Street
Pacific, MO 63069
(314) 378-2407
Michael Berra
- 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
- D. Section 260943.23 – Relay-Based Lighting Controls
- E. Section 262416 – Panelboards
- F. Section 262816.13 – Enclosed Circuit Breakers
- G. Section 263213.13 – Diesel-Engine-Generator Set
- H. Section 263236 – Resistive Load Banks
- I. Section 263613 – Non-Automatic Transfer Switches
- J. Section 263623 – Automatic Transfer Switches
- K. Section 265113 – Interior Lighting Fixtures, Lamps and Drivers
- L. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for the following items:
 - 1. Expansion anchors
 - 2. Concrete screw fasteners
 - 3. U-channel steel supports including associated hardware and accessories

PART 2 - PRODUCTS

2.1 GENERAL

- A. 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 Type 304 or Type 316 stainless steel or galvanized steel, stud type expansion anchor with a single-piece, three-section wedge, Hilti Kwik Bolt III or approved equal 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. All bolts shall have length identification.
- C. Concrete Screw Fasteners: Screw fasteners for mounting exposed nondimensioned junction and pull boxes on concrete walls shall be Type 304 or Type 316 stainless steel or galvanized steel, Hilti Kwik-Con II+ screw fasteners or approved equal installed per the manufacturer's written recommendations.
- D. Provide adequate corrosion resistance for all fastening systems.
- E. Bolts and Nuts: ANSI regular series, semi-finished, hexagon
 - 1. Indoors: Cadmium plated steel
 - 2. Outdoors and Inside Cave: Type 304 or Type 316 stainless steel
- F. Flat Washers:
 - 1. Indoors: Cadmium plated steel
 - 2. Outdoors and Inside Cave: Type 304 or Type 316 stainless steel
- G. Lock Washers: ANSI medium, spring type
 - 1. Indoors: Cadmium plated steel
 - 2. Outdoors and Inside Cave: Type 304 or Type 316 stainless steel
- H. Beam Clamps: Steel beam and angle clamps by B-Line or Thompson
 - 1. Indoors: Cadmium, zinc plated or hot-dipped galvanized
 - 2. Outdoors and Inside Cave: Type 304 or Type 316 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 inside buildings 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 and inside the cave shall be Type 304 or Type 316 stainless steel.
3. Prefabricated structural steel supports shall be 12-gauge, 1-5/8" x 1-5/8".

B. Hanger Supports: Threaded rods

1. Indoors: Electro-galvanized steel
2. Outdoors and Inside Cave: Type 304 or Type 316 stainless steel

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 is not permitted on any structure.
- 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 electrical equipment enclosures and mounting surface.
- I. Provide corrosion resistant spacers, minimum 1/4"-thick, behind all equipment enclosures mounted on concrete or masonry walls such that the back of the enclosure is not in direct contact with the wall.

3.2 ANCHORS AND FASTENERS

- A. Unless noted otherwise on the Drawings, expansion anchor embedment shall be as follows:

1. <u>Bolt Diameter, in.</u>	<u>Embedment, in.</u>
1/4	2
3/8	2-1/2
1/2	3-1/2
5/8	4
3/4	4-3/4

- B. Unless noted otherwise on the Drawings, embedment in concrete for concrete screw fasteners shall be 1 inch minimum and 1-3/4-inch maximum. Install concrete screw fasteners in accordance with the manufacturer's written instructions.
- C. Utilize beam clamps for attachment of electrical equipment and raceways to structural steel surfaces in accordance with the requirements of the Designer or Construction Representative.
- D. Utilize toggle bolts, hollow wall fasteners or through-wall bolt fasteners for attachment of electrical equipment, boxes and raceways to hollow masonry surfaces.
- E. Utilize machine screws for attachment of electrical equipment, boxes and raceways to metal surfaces.
- F. Utilize wood screws for attachment of electrical equipment, boxes and raceways to wood 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. Welding is not permitted. Provide bolted connections using structural member manufacturer's standard fittings and accessories.
- B. Do not use chain.
- C. Do not use perforated strap or wire.

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 or link seals
 - 5. Intumescent silicone sealant
 - 6. Conduit bodies
 - 7. Conduit mounting clamps
 - 8. Fire-stopping materials
 - 9. Conduit penetration sealing assemblies
 - 10. Protective coating for direct buried metal conduit
 - 11. Underground conduit warning tape

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 in sizes 1-1/4" and smaller.

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 shall be used outdoors above grade in sizes 1-1/2" and larger.

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 where required.
 - d. EMT shall be used indoors in dry locations.

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 Liguatite
 - 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 used where required.
 - 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) 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 be used below grade and inside the cave (on cave side of air lock doors).
 - 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 insulated throat, liquid-tight "copper-free" aluminum for aluminum conduit and zinc plated steel or malleable iron for rigid galvanized steel conduit, grounding type with ground lug/screw on the lock nut.
- B. Conduit hubs shall be Myers Type STAG or STG Scru-Tite or approved equal.

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 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 (standard or segmented style) or approved equal.
- C. External Conduit Sealing Bushings: Designed to seal around the outside of a conduit at below grade 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 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

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. Only those conduit bodies that are durably and legibly marked by the manufacturer with their cubic inch capacity shall be permitted to contain splices, taps, or devices. 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 or Type 316 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 or Type 316 stainless steel to match channel support material, B-Line B2000 Series or approved equal.

2.7 CONDUIT SLEEVES

- A. Sleeves shall be rigid galvanized steel conduit having square cut ends.
- B. Sleeves for installation in new concrete or masonry construction shall be provided with 1/4” x 1” anchoring lugs welded on.

2.8 FIRE-STOPPING MATERIALS

- A. The following fire-resistant penetration sealing materials are approved:
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

2.9 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 in lieu of fire-stopping materials.
- 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.

2.10 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 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.

2.12 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.

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 install all conduit 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 7'-6" 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, scars, or wrench abrasions in rigid galvanized steel conduit with an approved organic zinc rich primer equivalent to Koppers' "Organic Zinc."
19. 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.
20. 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 10 feet and within 3 feet of all terminations.
21. Where possible, group conduits on U-channel conduit racks.
22. Utilize U-channel supports and associated fittings and hardware for conduit support in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.
23. 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.
24. 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.
25. Grounding and bonding of conduit shall be in accordance with Section 260526 – Grounding and Bonding for Electrical Systems.
26. Identify all conduit runs; both new conduit and existing that is reused, in accordance with Section 260553 – Identification for Electrical Systems.
27. 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.

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 building electrical system or an electrical 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.
- C. Provide external conduit sealing bushings at all underground conduits entering a building or the cave air lock from below grade. Sealing devices shall be installed from the inside of the building or cave air lock such that all bolts in the sealing bushing or link seal are accessible
- D. 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 are not permitted to contain splices, taps, or devices.
 5. Conduit bodies shall be supported in a rigid and secure manner.
- E. 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.
 2. Only Type 304 or Type 316 stainless steel U-channel support conduit clamps shall be used outdoors or inside the cave.
- F. 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 concrete or masonry 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 and sleeves through which a conduit passes in 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.

G. 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 underground conduits entering an underground utility structure or building below grade shall be sealed using an external conduit sealing bushing.
7. External conduit sealing bushings shall be installed from the inside of the underground utility structure or building such that all bolts in the sealing bushing or link seal are accessible.
8. 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.
9. 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.
10. Underground conduits shall be at least 12 inches away from gas, water or other pipelines.
11. Conduits shall have long swept elbows.
 - a. Size 2" and below – 24" minimum radius
 - b. Size 2-1/2" and above – 36" minimum radius
12. Factory elbows for underground conduits in sizes 2 inches and larger shall be rigid galvanized steel Schedule 40.
13. Couplings for conduits in a common trench shall be staggered at least 6 inches. All joints shall have watertight seals.
14. All PVC conduit couplings, connectors and fittings shall be properly glued to the conduit, pushing the conduit all the way into the stop on the coupling, and using the adhesive recommended by the manufacturer of the PVC conduit.
15. Seal all around the cables or conductors inside all conduits entering handholes or underground junction boxes with intumescent silicone sealant to prevent entry of water, vermin, or debris in the conduit.

H. UNDERGROUND CONDUIT WARNING TAPE

1. Unless otherwise indicated, the location of all directly buried electrical 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.

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 Construction Representative and obtain, if possible, the exact location of any privately underground structures or utilities located in the vicinity of the excavation.
- C. 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.
- D. 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.
- E. 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
- G. Section 262726 – Wiring Devices
- H. Section 265113 – Interior Lighting Fixtures, Lamps and Drivers
- I. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

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
 - 3. Enclosures for cave feature lighting fixture power supply units, cave guardrail LED strip lighting fixture drivers and junction boxes located inside the cave
 - 4. Junction boxes for underground conduit

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 nondimensioned 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 as per 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. Raised device covers (plaster rings) for flush boxes shall be provided as required.
- 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 for concealed indoor work shall be galvanized drawn steel. Boxes shall be provided with a blank galvanized steel cover or extension ring, as required.
- G. Boxes shall be as manufactured by Appleton Electric Company, Eaton B-Line, Eaton Crouse-Hinds, E-Box, Hoffman Engineering Company, Killark Electric Manufacturing Company, O-Z/Gedney Company, Raco, Robroy-Stahlin, Steel City, Wiegmann or approved equal.

2.2 BOXES FOR NONHAZARDOUS AREAS

- A. Nondimensioned 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. Nondimensioned junction boxes located outdoors or inside the cave shall be cast, cadmium or zinc plated malleable iron 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. Device boxes located outdoors or inside the cave shall be cast, cadmium or zinc plated malleable iron having threaded hubs and neoprene gasketed covers fastened with four (4) stainless steel screws, NEMA Type 4, Crouse-Hinds, Appleton Electric, Killark or O-Z/Gedney 2-1/8 inch deep Type FD or approved equal.
- D. Dimensioned junction and pull boxes located indoors 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.
- E. Dimensioned junction and pull boxes located outdoors, above grade shall be Type 304 or Type 316 stainless steel, NEMA Type 4X having hinged, neoprene gasketed covers fastened with Type 304 or Type 316 stainless steel screws, and continuously welded seams (ground smooth) with no holes or knockouts.
- F. Enclosures for cave feature lighting fixture power supply units, cave guardrail LED strip lighting fixture drivers and junction boxes located inside the cave shall be polycarbonate IP68 per IEC 60529 and NEMA Type 6P per UL508A, UL50 and UL50e and F1 rated per UL746C. Enclosures for cave lighting fixture power supply units and drivers shall have a fiberglass inner back panel and hinged gasketed door with a minimum of one stainless steel screw or bolt in each corner. PSU and driver enclosures and junction boxes located inside the cave shall be Stahlin Polystar Series with opaque

cover and with external polycarbonate mounting feet secured to each corner of the back of the box with stainless steel screws or bolts.

- G. 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.
- H. Provide hinged cover enclosures for any box larger than 12 inches in any dimension.
- I. 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.
- J. Inner Back Panels: Provide white painted steel, galvanized steel, code gauge sheet aluminum or Type 304 or Type 316 stainless steel or fiberglass inner back panel, to match box construction, inside all boxes in which terminal blocks or electrical devices are located.

2.3 JUNCTION BOXES FOR UNDERGROUND CONDUIT AND LOW VOLTAGE CONDUCTORS

- A. Grass and Sidewalks: High strength, heavy duty, stackable composite box and cover with 15,000# minimum design rating. Removable cover shall be skid resistant with tamper resistant penta-head stainless steel cover screws. Junction box shall be suitable for sidewalks or grass areas. Junction boxes shall be PC or PG style, stackable, without bottom, as manufactured by Quazite, or approved equal by Highline Energy Products, Jensen Precast or NewBasis.
- B. Boxes containing low voltage (≤ 600 volts) conductors shall have the word "ELECTRIC" cast into the top surface of the cover.
- C. Size boxes in accordance with NEC Article 314-28. Minimum dimensions shall be as indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. BOXES, GENERAL

1. 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.
2. Locate and install to maintain headroom and to present a neat appearance.
3. 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.
4. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls.
5. Outlet boxes in unfinished areas shall be surface (exposed) mounted to columns or walls, unless otherwise indicated.
6. The location of all outlets and switches 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. Generally, switches are to be grouped with a gang cover plate and installed on the wall adjacent to the latch side of the door.
8. Final correct readjustment shall be made to outlets, 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.
9. Exposed nondimensioned junction and pull boxes mounted on concrete walls shall be attached either with Hilti "Kwik-Con II+" fasteners or approved equal, or to permanent U-channel inserts. Install "Kwik-Con" fasteners in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.
10. All boxes shall be rigidly mounted.
11. 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.
12. 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.
13. All open conduit knockouts, holes or hubs 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 gasketed stainless-steel blanking devices for stainless steel boxes and enclosures. Utilize NEMA 12 rated gasketed hole seals to seal all open holes in the top of all panelboards, switchboards, switchgear and dimensioned junction and pull boxes located indoors.
14. 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.
15. 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.
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. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
18. 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.
19. 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.
20. Cables connecting to IP68/NEMA 6P rated enclosures and junction boxes shall be terminated with non-metallic IP68/NEMA 6P rated cable gland fittings.
21. PVC jacketed Type MC cables connecting to IP68/NEMA 6P rated enclosures and junction boxes shall be terminated with stainless steel or nonmetallic IP68/NEMA 6P connectors.

3.2 CIRCUIT IDENTIFICATION

- A. All electrical enclosures, junction, pull and device boxes shall be identified in accordance with the requirements of Section 260553 – Identification for Electrical Systems.
- B. Cover plates for all 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 in accordance with Section 260553 – Identification for Electrical Systems.
- C. All conductors in a 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 260519 – Low-Voltage Electrical Power Conductors & Cables
- C. Section 260526 – Grounding and Bonding for Electrical Systems
- 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 260943.23 – Relay-Based Lighting Controls
- H. Section 262416 – Panelboards
- I. Section 262726 – Wiring Devices
- J. Section 262816.13 – Enclosed Circuit Breakers
- K. Section 263213.13 – Diesel-Engine-Driven Generator Set
- L. Section 263236 – Resistive Load Banks
- M. Section 263613 – Non-Automatic Transfer Switches
- N. Section 263623 – Automatic Transfer Switches
- O. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

1.4 SUBMITTALS

- A. Submit electrical identification data as follows:
 - 1. Nameplate type product data
 - 2. Nameplate engraving schedule
 - 3. Wire and cable identification label product data
 - 4. Conduit marker product data

5. Arc flash risk assessment warning label product data

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplates shall be three-layer laminated plastic with engraved black characters on a white background.
- B. Nameplate engraving shall be as follows:
 1. Lettering font shall be Gothic.
 2. Nameplate character sizes shall be:
 - a. 1/2-inch high – Panelboards, enclosed circuit breakers, resistive load banks, non-automatic transfer switches and automatic transfer switches.
 - b. 3/8-inch high – Individual branch circuit breakers in panelboards 400A and larger, control panels, terminal boxes, dimensioned junction boxes and dimensioned pull boxes, cave feature lighting fixture power supply unit enclosures and cave guardrail LED strip lighting fixture driver enclosures.
 - c. 1/8-inch high – Local control stations
 3. Lettering shall be centered on nameplate.
 4. Nameplates shall have a maximum of twenty (20) characters per line with a maximum of four (4) lines.
 5. Wording on nameplates shall include the equipment designation as indicated on the Drawings.
 6. In addition, panelboards, control panels, enclosed switches, enclosed circuit breakers, automatic transfer switches, cave feature lighting fixture power supply unit enclosures, cave guardrail LED strip lighting fixture driver enclosures and terminal boxes shall also have an engraved nameplate indicating the source panel it is served from and the service voltage and number of phases/wires such as: “120/240V-1PH-3W” or 120VAC”.
 7. Engraving designations shall be approved by the Designer.
- C. Special nameplates shall be 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 smaller1/2" characters
 2. Conduits 1-1/2" and larger1" characters
- B. Markers shall identify voltage and functional use of the conduit, such as “120/240 VOLT”, “120 VOLT”, “CONTROL”, 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 Designer.

2.4 ARC FLASH RISK ASSESSMENT 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 resistant to ultraviolet light and weather resistant.
- 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 study 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 labels based on the arc flash risk assessment report 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 400: 3.5” x 5”
 2. Equipment main bus rating 400A or more: 5” x 7”

2.5 COLOR CODE TAPE

- A. Each conductor, except control and signal conductors, shall be color coded with 3M No. 35 tape, 3/4” width, or colored insulation.
 1. Color coding for 600-volt conductors shall be:

120/240V 1 Phase

Phase A Black
Phase B Red
Neutral White
Equipment Ground Green

- B. Switch legs for local wall switches shall be brown.
- C. Wiring to contacts powered from an external source shall be yellow.
- D. Conductors for direct current (DC) circuits shall be color coded red for positive (+) conductor and black for negative (-) conductor.

2.6 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.

3.2 NAMEPLATES

- A. Nameplates shall be provided for each panelboard, enclosed circuit breaker, resistive load bank, non-automatic transfer switch and automatic transfer switch, control panel, terminal box, dimensioned pull box, dimensioned junction box, cave feature lighting fixture power supply unit enclosure, cave guardrail LED strip lighting fixture driver enclosure and local control station.
- B. Nameplates shall be secured with an approved adhesive such as Goodyear "Pliobond" glue.

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 readily visible location.

3.4 WIRE LABELS AND CABLE MARKERS

- A. 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 ARC FLASH RISK ASSESSMENT WARNING LABELS

- A. 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. Panelboards and switchboards without a door shall have one label applied to the outside front, near the center, of each individual section.
- B. Switchboards and panelboards having multiple sections shall have one 5" x 7" label applied to each section.
- C. 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.

3.6 COLOR CODE TAPE

- A. Code all wire and cable not available color coded from manufacturer by application of electrical plastic tape in colors specified. Apply tape in 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.

3.7 JUNCTION, PULL, OUTLET AND DEVICE BOX IDENTIFICATION

- A. Cover plates for all non-dimensioned junction and pull boxes shall be marked on the outside surface of the cover plate with the voltage, panel and circuit number 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. Cover plates for all GFCI receptacles shall be marked on the outside surface of the cover plate with panel and circuit number of the branch circuit serving the device. Marking shall be with printer generated "peel and stick" labels.

3.8 PANELBOARD CIRCUIT DIRECTORIES

- A. Provide new "updated" directory cards for existing panelboards in which circuits have been rearranged, added or deleted.
- B. The directory card shall be typewritten or printer generated to identify the load served by each circuit and then laminated in clear plastic for moisture protection.
- C. Trace out unidentified circuits in existing panels 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 Engineer 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 262416 – Panelboards
- D. Section 262813 – Fuses
- E. Section 262816.13 – Enclosed Circuit Breakers
- F. Section 263213.13 – Diesel-Engine-Driven Generator Set
- G. Section 263236 – Resistive Load Banks
- H. Section 263613 – Non-Automatic Transfer Switches
- I. Section 263623 – 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 (2020 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; panelboards, 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, 30” x 42” maximum size, are required for legibility. Securely retain larger size drawings by folding and placing in pockets bound into report.
 2. Provide one complete copy of all report documentation on CD or DVD 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, on CD or DVD to include all models, data, single lines, etc.
- D. General report requirements:
1. Include complete electrical distribution system for the Visitors Center and Onondaga Cave up to the 120/240V, 1-phase main Crawford Electric service pad-mount transformer and the new 50kW, 120/240V, 1-phase diesel-engine-driven emergency generator.
 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 the 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 shall include the new emergency generator.
- 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 Contractor provided equipment shop drawings 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.

1.5 APPLICABLE STANDARDS

- A. ANSI/IEEE C37.46 – Power Fuses and Fuse Disconnecting
- B. ANSI Z535.4 – Product Safety Signs and Labels, Includes Errata
- C. ICEA P-32-382 – Short Circuit Characteristics of Insulated Cable
- D. ICEA P-45-482 – Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables
- E. IEEE 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

- F. IEEE 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book).
- G. IEEE 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)
- H. IEEE 1015 – IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (IEEE Emerald Book).
- I. IEEE 1584 – IEEE Guide for Performing Arc Flash Calculations, Includes Amendments and Errata
- J. NFPA 70 – National Electrical Code
- K. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
- L. NFPA 70E – Standard for Electrical Safety in the Workplace
- M. 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 State of Missouri 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 manufacturer of the new panelboards per Section 262416 – Panelboards or other qualified State of Missouri registered professional engineer, such as Corey Jasper, P.E., BHMG Engineers, Inc. (314-686-1216), subject to approval of the Owner and 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 SKM Power Tools

Electrical Engineering Software (PTW 32) by SKM Systems Analysis, Inc., or approved equal by 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. Examine protective device submittals 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.
- B. 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.
- C. Field verify all information shown on the electrical one-line diagrams, 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
- D. Update project one-line diagrams with information obtained from field verifications

1.11 FAULT-CURRENT STUDY

- A. Fault study shall include the following available fault current:
 - 1. Primary Fault Data:
 - a. Source Case 1:

- i. Utility Source: Verify values with Kurtis Reed, Engineering Manager at Crawford Electric, 573-732-4415 X160.
 - b. Source Case 2:
 - i. Generator Source: Verify values with manufacturer of equipment provided under Section 263213.13 - Diesel-Engine-Driven Generator Set.
 - c. Existing Transformer Data: Verify with Crawford Electric whether this transformer is to be replaced.
 - i. Mineral Oil Insulated
 - ii. 1-phase
 - iii. 12.47Y/7.2kV – 120/240V
 - iv. 50 kVA
 - v. 1.9% Z
 - vi. Primary Fuse: Verify with Kurtis Reed at Crawford Electric
 - vii. Verify with Kurtis Reed at Crawford Electric whether this transformer is to be replaced before proceeding with the study using information from the existing transformer.
- B. Study electrical distribution system for both the “Case 1” and “Case 2” source scenarios using an approved computer software program to calculate values in order to determine the maximum fault conditions.
 - C. Calculate momentary and interrupting duties based on the maximum available fault current.
 - D. 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
 - E. Fault study must be completed and submitted prior to proceeding with procurement/manufacturing of any of the following equipment:
 - 1. Generator Distribution Switchboard under Section 262413 – Switchboards
 - 2. Diesel-Engine-Driven Generator Set output circuit breakers under Section 263213.13 – Diesel-Engine-Driven Generator Set
 - 3. Resistive Load Bank under Section 263236 – Resistive Load Bank
 - 4. Non-Automatic Transfer Switches under Section 263613 – Non-Automatic Transfer Switches
 - 5. Automatic Transfer Switches under Section 263623 – Automatic Transfer Switches
 - F. 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 momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.
 - G. 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 electrical distribution system equipment located in the Visitors Center and the Onondaga Cave up to the 120/240V, 1-phase main Crawford Electric service pad-mount transformer and the new 50kW, 120/240V, 1-phase diesel-engine-driven emergency generator.

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. Circuit-breaker and fuse-current ratings and types
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection types, impedance, and X/R ratios
 - d. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length
 - e. Motor horsepower and code letter designation according to NEMA MG 1
 3. Study specialist must visit the project site to field verify the information shown on the project drawings and to confirm the lengths of existing feeders to a reasonable level of accuracy.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram
 - a. Special load considerations
 - 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. 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 circuit breakers
 - f. Panelboards interrupting rating 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 242 time intervals.
- F. 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.
- G. 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. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings
 - c. Fuse-current rating and type
 - 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. No damage, melting, and clearing curves for fuses
 - d. Cable damage curves
 - e. 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 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, if overcurrent devices are field adjustable.
- 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. Provide arc flash risk assessment warning labels in accordance with NEC Article 110.16 and NFPA 70E for the following equipment:
 - a. All new panelboards, enclosed circuit breakers, generator output circuit breakers, non-automatic transfer switch, automatic transfer switch and the resistive load bank provided on this project.
 - b. Existing panelboards and disconnect switches inside the Visitors Center.
 - c. All panelboards and disconnect switches in the series electrical path from the electrical equipment specified herein as needing a label up to the main power transformer serving the Visitors Center and Onondaga Cave.
- D. Arc Flash Risk Assessment:
 - 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.
- E. Comply with NFPA 70, NFPA 70E, and NFPA 70B standards for the Study Report.
- F. Field Labeling and Signage:
 - 1. Provide complete arc flash hazard warning signage per NFPA 70 Article 110.16 at each panelboard, enclosed circuit breaker, enclosed switch (safety disconnect switch), motor starter, diesel-engine-driven generator set, resistive load bank, non-automatic transfer

switch, automatic transfer switch, and other equipment if/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.
3. The source protective device name providing the protection (fed from) on each arc flash hazard warning label shall use the designations of equipment shown on the Project Drawings rather than names assigned within the power system study software model.

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 shall 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 provided electrical equipment preventative maintenance training.

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, and 600-volt shielded instrumentation cable 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 262726 – Wiring Devices
- F. Section 260943.23 – Relay-Based Lighting Controls
- G. Section 262416 – Panelboards
- H. Section 262726 – Wiring Devices
- I. Section 262816.13 – Enclosed Circuit Breakers
- J. Section 263213.13 – Diesel-Engine-Driven Generator Set
- K. Section 263236 – Resistive Load Banks
- L. Section 263613 – Non-Automatic Transfer Switches
- M. Section 263623 – Automatic Transfer Switches
- N. Section 265113 – Interior Lighting Fixtures, Lamps and Drivers
- O. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

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
 - 3. 600-volt pin adapters

4. 600-volt splice insulating materials
5. Underground junction box and cave junction box splice waterproof sealing packs

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. Insulated Multi-Conductor Connectors: Multi-port, mechanical connector, with 3/0 to 6 AWG wire range for copper or aluminum conductors, UV, abrasion and chemical resistant high dielectric strength black plastisol insulation with removable access plugs over hex screws, UL 486B Listed, 90°C, 600-volt sized for the quantity and size of conductors to be jointed; Polaris, IlSCO or Morris.
- C. 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.
- D. 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 spade 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.
 3. Spring type, twist-on splices located in underground junction boxes and in junction boxes in the cave shall be waterproofed using 3M No. 3570 epoxy resin sealing pack or approved equal.
- E. 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.
- F. Power Connections and Terminations:
 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. Utilize compression pin adapters for terminating conductors at equipment lugs when lug is too small for conductor to be terminated.
 - a. Short barrel compression connector with solid reducing pin suitable for use with stranded copper building wire

- b. EDPM rubber insulating cover
 - c. Burndy AYP Series or approved equal by IlSCO or Morris
4. Feeder tap splices shall only be made where specifically indicated on the Drawings or where pre-approved by the Designer.
 - a. Spring type, twist-on splice connectors as specified herein. For size 6 AWG and smaller conductors only.
 - b. Insulated, direct burial rated, 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.
 5. In-line feeder 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. Size 12 AWG through 3/0 AWG connectors, for splicing different sized conductors, shall be Thomas & Betts C-Tap compression connections or approved equal. Overwrap connectors with a minimum of three (3) half-lapped layers of Thomas & Betts Shrink-Kon TBFT201-36 self-fusing insulation tape.

G. Power Termination Insulation:

1. Insulating Putty: 3M Scotchfil electrical insulating putty or approved equal by Thomas & Betts
2. Insulating Tape: 3M Scotch 23 or Thomas & Betts Shrink-Kon TBF201-36 self-fusing insulating tape
3. Jacketing Tape: 3M Scotch 33+ jacketing tape
4. For in-line splices, provide pre-engineered cold shrink or heat shrink insulating kits by 3M, Raychem, or Thomas & Betts in lieu of tape insulation, when available.
5. Spring type, twist-on splices located in underground junction boxes and in junction boxes in the cave shall be waterproofed using 3M No. 3570 epoxy resin sealing pack or approved equal.

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.
- C. All splices in underground junction boxes and handholes and in junction boxes in the cave shall be waterproof in accordance with NEC 314-30(C).

3.2 CONTROL WIRING CONNECTIONS AND TERMINATIONS

- A. Thoroughly clean wires before installing connectors.
- B. Tape back spare conductors with 3M Scotch 33+ jacketing tape.
- C. Where attachment is to a terminal block screw or stud, install using pre-insulated spade 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, twist-on splice connection except those located in underground junction boxes and in junction boxes in the cave shall be waterproofed using 3M No. 3570 epoxy resin sealing pack or approved equal.

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, twist-on splice connection except those located in underground junction boxes and in junction boxes in the cave shall be waterproofed using 3M No. 3570 epoxy resin sealing pack or approved equal.
 - 3. Conductor to conductor splicing of more than two conductors or conductors of different sizes shall utilize insulated multi-conductor mechanical set screw connectors.
- 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.

4. At equipment with lugs sized too small for conductor termination utilize compression pin adapters of the appropriate size with EDPM insulating cover. Utilize the proper tool/die for installing the adapter on the end of the conductor.

3.4 600-VOLT POWER TERMINATION INSULATION

- D. Insulate with pre-engineered kits where appropriate, or with a minimum of three (3) half-lapped layers of insulating tape covered with three (3) half-lapped layers of jacketing tape. Where major surface irregularities exist, fill voids with insulating putty prior to application of insulating tape.
- E. Provide electrical insulating putty to fill major irregularities and voids in termination prior to taping.
- F. Apply self-fusing insulating tape directly to the conductors or over the electrical insulation putty.
- G. Apply jacketing tape over the insulating tape to provide an outer covering for the cable termination.
- H. Splices made using spring type, twist-on splice connectors shall be insulated with a minimum of three (3) half-lapped layers of the specified jacketing tape except those located in underground junction boxes and in junction boxes in the cave shall be waterproofed using 3M No. 3570 epoxy resin sealing pack or approved equal.

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:
 - c. Summary of test results
 - d. Test equipment summary (model number, accuracy, calibration date)
 - e. Test personnel names and sign-offs
 - f. Completed data sheets
 - g. Test log and observations
 - h. 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 260943.23 – RELAY-BASED LIGHTING 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 and install relay-based lighting controls for the cave lighting system specified under Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers.
- B. Furnish engineering, labor, materials, apparatus, software, programming, tools, equipment, transportation, temporary construction, testing, commissioning, system administrative support throughout the installation process and special or occasional services as required to make a complete and operational relay-based lighting control system, 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 and Arc Flash Risk Assessment
- F. Section 260583 – Wiring Connections
- G. Section 262416 - Panelboards
- H. Section 262813 – Fuses
- I. Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers

1.4 SECTION INCLUDES

- A. UL508A Listed and Labeled cave power and lighting control cabinets
- B. Cave lighting control stations
- C. Work to be furnished by the Electrical Contractor:
 - 1. Installation of power/control cabinets and lighting control stations inside the cave
 - 2. All power and control wiring to and from the power/control cabinets as indicated on the drawings provided by the UL 508A panel builder

3. All cables connecting to lighting control stations as indicated on the drawings provided by the UL 508A panel builder.

1.5 SYSTEM DESCRIPTION

- A. Detailed design and fabrication of eight (8) new power/control cabinets and fifteen (15) new lighting control stations to provide relay-based control of the new LED cave lighting system as specified in Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers and as shown on the Drawings.
- B. Each power/control cabinet shall include, but not be limited to, the following components:
 1. NEMA 4X Type 304 or 316 stainless steel double door enclosure with stainless steel inner back panel(s)
 2. 120/240V, 1-phase, 3-wire circuit breaker panelboard in Type 1 door-in-door painted steel enclosure in accordance with Section 262416 - Panelboards
 3. Enclosure ground bus
 4. DIN rail mounted components as necessary to create a complete and operational relay-based lighting controls system, including but not limited to:
 - a. 120VAC to 24VAC control power transformer
 - b. Finger safe IEC terminal blocks
 - c. Enclosure anti-condensation heater and thermostat
 - d. Control relays
 - e. Lighting contactors
 - f. Fused terminal blocks
- C. Each lighting control station shall include, but not be limited to, the following components:
 - a. IP68 non-metallic enclosure
 - b. IP68 push buttons
 - c. Labeling on front of enclosure for each push button

1.6 ACTION SUBMITTALS

- A. Manufacturer's product technical data sheets shall be submitted for all components, including but not limited to:
 1. Power/control cabinet enclosures, including each component installed within except that the panelboards shall be submitted under Section 262416 - Panelboards.
 2. Enclosures for lighting controls stations
 3. Lighting control push buttons
- B. Shop drawings for power/control cabinets shall include, but not be limited to, the following:
 1. Complete Bill of Materials
 2. Dimensioned outline drawings for exterior and interior of enclosure
 3. Wiring diagrams showing all internal and field connected power and control wiring, including interconnections between the power/control cabinets and the LED lighting fixture power supply units and lighting control stations.
- C. Shop drawings for lighting control stations shall include, but not be limited to, the following:
 1. Complete Bill of Materials

2. Dimensioned outline drawings for the enclosures, including push button arrangements
 3. Wiring diagrams showing all internal and field connected power and control wiring
 4. Labeling drawing for the push button control stations
- D. Schedules: Provide schedule for push button labeling for each lighting control station.
- E. Point to point field cable interconnection drawings.
- F. Power/control cabinet builder's UL 508A certification in good standing.
- G. Manufacturer shall provide any additional information, including equipment mockup demonstrations, to verify compliance with specification requirements.
- H. Qualifications for relay-based lighting control system field startup technician.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data to be provided in accordance with Division 1 requirements shall include the following:
1. Manufacturer's specification sheets, operating specifications, design guides, user guides for all hardware components.
 2. System installation and setup guides with data forms used to plan and record options and lighting control decisions.
- B. Factory Test Reports
- C. Field Startup and Commissioning Test Reports
- D. Record Drawings:
1. During construction maintain red-lined "as-built" drawings indicating all field changes to power/control cabinets and lighting control stations. Document all changes to component makes, models and mounting locations and to wiring of all components.
 2. Project Record Drawings shall accurately show the physical placement of the following:
 - a. Power/control cabinets
 - b. Lighting control station locations
 - c. Junction and pull box locations
 - d. Interfaces to external equipment
 - e. Power and control circuit connections
- E. System Documentation:
1. Control Schematics: Provide control schematics showing interface circuits for each piece of equipment, termination and connection diagrams including wire/cable numbers
 2. Provide a complete collection of all installation, operation, maintenance manuals and work sheets relating to the equipment provided as part of the Work.
 3. Upon completion of the Work, and prior to Final Acceptance, Contractor shall prepare and submit three (3) sets of System Documentation.

1.8 QUALITY ASSURANCE

- A. The UL 508A industrial control panel design-builder shall be one who has been continuously engaged in designing and building industrial control panels similar to those required on this project for a minimum of fifteen (15) years.
- B. The UL 508A industrial control panel design-builder's primary manufacturing location, with at least one full time service technician on staff, shall be located within 120 miles of the project site.
- C. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc. and the National Electrical Code. The power/control cabinets shall be UL 508A listed and labeled.

1.9 ACCEPTABLE SUPPLIERS

- A. The equipment and services herein specified shall be furnished by:
 - 1. Custom Control Solutions
680 C Crown Industrial Court
Chesterfield, MO 63005
Lisa Boyer
Email: lisa@ccs-mo.com
Phone: 636-778-9699
 - 2. Electric Controls Company
2735 Mercantile Dr.
St. Louis, MO 63144
Mark Price
Email: mprice@eccstl.com
Phone: 314-290-2919
 - 3. KT Power Systems
433 County Road 638
Cape Girardeau, MO 63701
Email: robin@KTPowersystems.com
Phone: 573-579-1656
 - 4. Approved equal Category NITW UL508A certified industrial control panel manufacturer

1.10 EXTRA MATERIALS

- A. Provide 10% spare parts, of total quantity used on the Project, (except as noted otherwise below) for each of the following (round all fractional amounts up to next complete device):
 - 1. Each type of control relay
 - 2. Each type of lighting contactor
 - 3. Each type of control power transformer
 - 4. Enclosure anti-condensation heater and thermostat
 - 5. Each type and size fuse (place five (5) of each size and type inside each power/control cabinet)
 - 6. Each type of lighting control push button

1.11 WARRANTY

- A. Contractor shall warrant all material and labor furnished as specified herein and shown on the Drawings to be free from defects in materials and workmanship, under normal use and service,

for a period of two (2) years after Date of Acceptance, except where any specific warranties or guarantees from a supplier or equipment manufacturer extends for a longer period of time.

- B. Contractor's warranty/guarantee shall cover all costs associated with the troubleshooting, repair, and replacement of defective Work, including the costs of labor, transportation, lodging, materials, equipment, tools and consumables.
- C. Contractor shall promptly respond to the Owner's requests for service during the warranty period. Contractor shall provide repair service as soon as reasonably possible upon request from the Owner, but in no case shall service response exceed 8 hours from time of request.
- D. Contractor shall provide a service report for each service visit, indicating reported problem/condition, issues found and corrective action taken for problem resolution.

PART 2 - PRODUCTS

2.1 POWER/CONTROL PANELS

- A. All control power transformers, lighting contactors, control relays, terminal blocks, anticondensation heaters and miscellaneous devices and hardware shall be mounted in a factory wired power/control cabinet fabricated in a UL 508A certified industrial control panel shop (Category Code NITW). The completed control panel shall be UL 508A listed and labeled. Where more stringent requirements than specified herein are required by UL 508A the UL 508A requirements shall govern. The control panel short circuit current rating (SCCR) shall be a minimum of 10,000 amps RMS symmetrical.
- B. Control power for lighting control push button stations shall be 24VAC.
- C. Power/Control Panel Enclosure:
 - 1. Power/control panel enclosure shall be UL508A Listed, 14 gauge with 12 gauge back Type 304 or 316 stainless steel, NEMA Type 4X wall-mount cabinet with no holes or knockouts. Provide with 10-gauge stainless steel inner back panel and with external stainless steel mounting brackets.
 - 2. Power/control panel enclosure shall be of sufficient width and depth to accommodate the 120/240V circuit breaker panelboard and all control devices.
 - 3. Seams shall be continuously welded and ground smooth. Outside corners shall have a 1/4-inch radius.
 - 4. Power/control panel enclosure shall be front opening with two (2) full height doors. Each door shall have concealed hinge(s) with stainless steel hinge pin(s) and three-point latching mechanism operated by an oil-tight, key-locking handle.
 - 5. Each door shall be removable by pulling out the hinge pin(s).
 - 6. The door center post shall be removable to allow installation of the inner back panel.
 - 7. Latch rods shall have rollers for easier door closing.
 - 8. A data pocket shall be provided on the inside of one of the two doors.
 - 9. Provide seamless, oil- and water-resistant foam-in-place door gaskets.
 - 10. Provide cabinet grounding stud(s) with bonding provision on both doors.
 - 11. Manufacturer: Eaton B-Line, nVent Hoffman, or Saginaw Control & Engineering
- D. Fasteners required for mounting devices shall not be visible on the outside of the enclosure; i.e., no fasteners shall penetrate the exterior of the enclosure or the enclosure doors. The arrangement of devices within the enclosure shall be subject to the Designer's approval as part of the shop drawing submittal process.

- E. All internal components shall be fastened to the inner back panel. Drilling for mounting of equipment shall not be done until a check of dimensions with equipment to be installed has been made. Tapped holes shall be used. Self-tapping or sheet-metal screws are not allowed.
- F. PVC jacketed Type MC power and control cables shall enter the bottom of the enclosure through appropriately sized holes. Use a knockout punch. Do not use a step drill bit or hole saw.
- G. A nameplate shall be furnished for each item on the control panel describing the function of the item. Nameplates shall be white laminated plastic with black engraved characters, minimum 3/16" high. Permanent nameplates or tags shall also be provided inside panels to label all devices.
- H. Control relays: Provide control relays to interface between the lighting control push buttons and the lighting contactors as required to implement the lighting control design specified herein and as shown on the Drawings. Control relays shall have DPDT 15-amp AgCdO contacts, 24VAC coil, manufactured by Allen-Bradley, Eaton, Omron, Potter & Brumfield or Schneider Electric. Provide manufacturer's recommended DIN rail mounting base.
- I. Lighting contactors: Provide lighting contactors to control the 120VAC power input circuits to the cave feature LED lighting fixtures and cave handrail LED strip lighting fixtures by means of momentary push buttons using a 3-wire control scheme. Lighting contactors shall be electrically operated and mechanically held with 24VAC latch and unlatch coils and mechanical latch rod. Lighting contactors shall have double throw 30-amp AgCdO contacts. Number of contact poles shall be as required to implement the lighting control design specified herein and as shown on the Drawings. Lighting contactors shall be by ABB, Eaton or Square D.
- J. Control power transformers: Provide 120VAC to 24VAC control power transformer appropriately sized to supply control power for the lighting control circuits in each power/control panel. Provide fuse protection on both the primary and secondary sides of the control transformer.
- K. Enclosure anti-condensation heater and thermostat: Provide 120W resistive anti-condensation heater with thermostat inside each power/control panel enclosure to keep the interior of the enclosure dry.
- L. All power and control wiring shall be stranded copper, 600-volt single conductor, moisture and heat resistant, Type SIS panel wire, rated for 90°C. For power conductors, the minimum size shall be 14 AWG or as required by the National Electrical Code for circuits with overcurrent protection greater than 15 amps. For 24VAC control conductors, the minimum size shall be 16 AWG.
- M. All wiring and component installation shall be in accordance with the latest issue of the National Electrical Code. All components shall have Underwriters Laboratories, Inc. approval.
- N. All field and panel interconnection wiring shall be landed on DIN rail mounted, IEC finger safe terminal blocks inside the control panel.
 - 1. Terminals for 120VAC control and power wiring shall have a UL rating of 600VAC, 20A with a conductor range of 22 to 12 AWG; Entrelec 0115 486.03 or approved equal by Allen-Bradley, Phoenix or Weidmueller.
 - 2. Terminals for main power wiring shall have a UL rating of 600VAC, 30A with a conductor range of 22 to 10 AWG; Entrelec 0115 116.07 or approved equal by Allen-Bradley, Phoenix or Weidmueller.
- O. All interconnecting wiring from external devices to the panel, as well as interconnecting wiring within the panel, shall terminate at the terminal blocks. Terminal blocks shall be mounted on 1-1/2

inch stainless steel Z bracket supports using stainless steel T-35 DIN rail. No wire splices shall be allowed in the panel. Terminal blocks shall have no more than two (2) wires connected per termination point. Factory jumpers may be used where required. Jumpering of live voltages using non-insulated comb type jumpers will not be acceptable. Isolated comb jumpers, insulated wire jumpers or jumper bars shall be used.

- P. Each wire end shall be permanently marked with the source and destination of the wire. The wire markers shall be self-laminated vinyl, computer printable, Thomas and Betts Series WES or approved equal by Brady or Panduit. Provide clear shrink tubing over the labels.
- Q. Each terminal on the terminal block shall be permanently marked with the complete terminal number and shall be installed so as to be readable from left to right and top to bottom. Terminals shall be numbered with a permanent, nonconductive strip on each block according to the detailed wiring drawings to be provided by the equipment supplier. Wire numbers shall not be used to identify terminals on terminal blocks.
- R. Terminal blocks shall be grouped according to function and voltage level.
- S. Terminal blocks shall be installed a minimum of six inches above the bottom of the panel.
- T. Not less than two inches shall be provided between terminal blocks and wiring duct or equipment for ease in wiring and wire number legibility.
- U. Terminal block groups shall be permanently identified with an engraved laminated plastic nameplate as specified on the control panel drawings.
- V. All wires going to external devices shall be terminated at terminal blocks. No more than two wires shall be connected to the same terminal. Each wire shall be a continuous run. Splices will not be permitted.
- W. All stranded wire shall have a crimp-on pin (ferrule) installed prior to terminating on the final device or terminal block.
 - 1. Ferrules at stranded wiring terminations within the control panel shall be crimp-on hollow pin connector:
 - a. Lawson P61775 (for 18 AWG conductors)
 - b. Lawson P61780 (for 16 AWG conductors)
 - c. Lawson P61785 (for 14 AWG conductors)
 - d. Lawson P61790 (for 12 AWG conductors)
 - e. Or approved equals
- X. A copper ground bus to effectively ground the entire structure shall be provided (AC GROUND BUS). Provide sufficient terminals for termination of all AC grounding conductors.
- Y. All grounding conductors shall be identified with green insulation or green tape at termination points.
- Z. Plastic wiring duct shall be used to enclose panel wiring. Duct shall be Panduit Corporation Type F or equal by Betaduct or Kable Kontrol. The wire duct color shall be the same throughout the panel. The duct shall be securely fastened to the panel with screws and washers or rivets. Ducts shall be a maximum of 50 percent full. The 50-percent maximum fill provides capacity for future expansion.

- AA. Wiring shall be routed by duct wherever possible. Wire shall be neatly arranged within and exiting from duct. A small loop of wire shall be left in the wiring duct when connecting to terminal strips. Wire identifications shall not extend into the wire duct.
- BB. Wiring duct shall be provided from the entry point of external cable to the termination point of the cables. The AC wiring leading from the devices and terminal blocks to the field shall be formed to exit separately in dedicated areas at the bottom of the panel.
- CC. Field side of terminal blocks shall be free of wiring. An empty run of wiring duct shall be provided for field wiring.
- DD. Bundling of wires, except within covered wireway, shall be accomplished with nylon zip ties; Thomas and Betts “Ty-Raps” or approved equal by Brady or Panduit. The Contractor shall use the manufacturer’s installation tool to prevent sharp edges after the zip ties have been cut.
- EE. All wiring across hinges or to movable panels shall have Class C stranding and shall be protected by nylon spiral wrap. Secure with Thomas and Betts TC5828 mechanically installed zip tie mounting bases or approved equal by Brady or Panduit.
- FF. All components shall be arranged for easy access for future modification and maintenance. Panels shall have a minimum of a 2-inch space between outer edge of mounted components and side of panel. Panels shall have a minimum of 2-1/2-inch space between all mounted components and wire ducts. All devices in enclosures must be readily accessible.
- GG. All electrical nodes and switches, relays, contractors, remote devices and other control devices are to be wired to terminal blocks.
- HH. The control panel shall be quality checked and tested before shipment from the factory.
 - 1. All tags and nameplates shall be checked for correct color, size, letter size, spelling and location.
 - 2. Continuity and point-to-point tests of all wiring shall be performed.

2.2 LIGHTING CONTROL STATIONS

- A. Lighting control stations shall be provided as specified herein and as indicated on the Drawings to control cave feature LED lighting fixtures and cave handrail LED strip lighting fixtures.
- B. Lighting control station enclosures shall be IP68/NEMA 6P rated, non-metallic sized as required to house the number of push buttons indicated on the Drawings, with gasketed, hinged cover with appropriate latches and screws to secure the cover as required to maintain the IP68/NEMA 6P rating.
- C. Push buttons shall be low profile, stainless steel type, 19 to 22.5 mm in diameter with spring loaded momentary Form C contact. Installation of the push buttons in the cover of the enclosure shall not compromise the IP68/NEMA 6P rating of the enclosure or the push button. Push button contacts shall have a minimum rating of 1A at 24VAC.
- D. Color of the push buttons shall be as indicated on the Drawings:
 - 1. Yellow for all “special case” push buttons that are to be highlighted on the face of the control stations with a rectangle.
 - 2. Red for the “NO BLACKOUT” push button on control station S11.
 - 3. Black for all other push buttons

PART 3 - EXECUTION

3.1 GENERAL

- A. Equipment shall be factory wired and tested to the extent possible in accordance with the coordinated wiring diagrams that were submitted and reviewed during the shop drawing submittal process.
- B. Provide telephone support during the installation of the equipment as required and include two (2) on-site visits during the installation period to coordinate with the Electrical Contractor.
- C. Provide on-site checkout of the installation of the relay-based lighting control system prior to placing into permanent service.

3.2 COMMISSIONING

- A. Test each component separately and then the system as a whole, ensuring the individual components and the relay-based lighting control system function properly prior to complete integration testing.
- B. Provide complete on-site operational testing of the relay-based lighting control installation for and provide a startup and commissioning report signed by the UL 508A industrial control panel design-builder's field technician and the Construction Representative.

3.3 DOCUMENTATION

- A. Provide the following documentation:
 - 1. All original Installation, Operation and Maintenance Manuals for all equipment.
 - 2. All items required under Article 1.5 – Closeout Submittals.

3.4 TRAINING

- A. Provide a two (2) hour training session to instruct the Owner's facility personnel on the proper operation and maintenance of the relay-based lighting control system and to review the documentation and ensure everything is clear and well understood.

END OF SECTION 260943.23

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 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
- 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 sheets and shop drawings shall be submitted for each circuit breaker panelboard, including the circuit breakers.
- 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 and neutral and equipment ground busses.
 - 3. Location and connection arrangement for SPD.
 - 4. Type and ratings of all circuit breakers.
- C. 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: Articles 242 and 408
- E. UL 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations
- F. UL 67 – Standard for Panelboards
- G. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- H. UL 1283 – Standard for Electromagnetic Interference Filters
- I. UL 1449, 4th Edition – Standard for Surge Protective Devices

1.6 QUALIFICATIONS

- A. The manufacturer of the panelboard assemblies shall be the manufacturer of the major components within each assembly.

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.

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 FOR USE INSIDE THE CAVE

- 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 and integral, direct bus connected SPD. 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 and number of phases, poles and wires 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 steel, thoroughly cleaned and then coated on all sides with rust-inhibiting primer and finished with the appropriate number of coats of ANSI-49 or ANSI-61 light gray baked-on enamel paint. Each panelboard shall have an outer door and an inner door both equipped with a locking handle requiring a milled key. Furnish two (2) keys for each panelboard. 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 Type 1, door-hinged-to-box for installation inside a stainless steel power/control panel enclosure in accordance with Section 260943.23 – Relay-Based Lighting Controls.
- E. A framed circuit 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.
- F. All panelboard interiors shall be equipped with bus bars, 3/4" or 1" wide circuit breakers and adjustable means for positioning the interior within the enclosure.
- G. 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 are not acceptable.
- H. All bus bar conductors (phase, neutral, and ground) shall be fabricated from 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, shall meet the requirements of ASTM Specifications B 187, and shall be sized in accordance with Underwriters' Laboratories Standards. Neutral bus bar conductors shall be insulated from the panelboard and shall be the same size as the phase bus bar conductors.
- I. Bus bars shall extend the full height of the available space for mounting future circuit breakers.
- J. The panelboard interior shall be provided with a copper ground bus bar conductor, equal to at least 25% ampacity of the phase bus bar conductors, which shall be bonded to the panelboard enclosure.

- K. 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.
- L. The neutral bus bar and the ground bus bar shall not be electrically bonded together.
- M. 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.
- N. 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. "Twin" type circuit breakers that provide two circuit breakers in a single breaker position, bus connection, are not acceptable.
- O. Provide molded case, thermal magnetic main circuit breaker 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 terminating the quantity and size of stranded copper conductors indicated on the Drawings.
- P. 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.
- Q. Circuit breakers shall have a minimum short-circuit interrupting capacity of 10 kA RMS symmetrical amperes. Do not order 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.
- R. Provide spare circuit breakers as indicated on the Drawings.
- S. Single-pole circuit breakers in 120/240V panelboards having 15 or 20 ampere ratings shall be UL Listed as Switching Duty (SWD) rated.
- T. Circuit breakers shall include factory installed mechanical lugs that are UL listed to accept stranded copper conductors. 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.
- U. 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, left to right, top to bottom, front to back as viewed from the front of the panelboard.
- V. 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 blanking devices.
- W. 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.
- X. Integral Surge Protective Device (SPD):
 - 1. SPD shall be UL 1449 labeled with Surge Current Capacity Rating of 80kA per mode and 160kA per phase and a 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 242.10.

2. 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.
3. SPD shall be UL 1449 labeled with 20kA I-nominal (In).
4. Suppression components shall be heavy duty, thermally protected, 50kA MOVs.
5. SPD shall provide surge current paths for all modes of protection: L-N, L-G, N-G, and L-L for 120/240V, 1-phase, 3-wire systems.
6. SPD shall be integral to the panelboard and shall be directly mounted to the panelboard bus bars.
7. SPD shall meet or exceed the following criteria:

- a. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>Nominal Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>
120/240V, 60Hz	500V	600V	500V	800V

- b. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

<u>Nominal Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>
120/240V, 60 Hz	150V	150V	150V	300V

8. SPD shall have UL 1283 EMI/RFI filtering with active tracking up to 50dB from 10kHz to 100MHz.
9. SPD 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.

10. Environmental Conditions:

- a. Operating temperature: -4°F to 122°F
- b. Relative humidity: 5 – 95%, non-condensing

11. SPD shall be furnished by the same manufacturer as the panelboard and circuit breakers.
12. 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.

Y. 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 rating.

Z. All panelboards shall be built in accordance with and to meet the requirements of the applicable sections of the National Electrical Code, NEMA Publication PBI, OSHA and applicable UL standards. All panelboards shall bear the Underwriters' Laboratories (UL) label of approval.

AA. Circuit breaker panelboards shall be:

1. ABB ReliaGear Type RQ with Type THQB bolt-on circuit breakers
2. Eaton Type PRL1X with Type BAB bolt-on circuit breakers
3. Square D Type NQ with Type QOB bolt-on circuit breakers

BB. All panelboards and enclosed circuit breakers, under Specification Section 262816.13 – Enclosed Circuit Breakers, shall be provided from the same manufacturer.

2.2 CIRCUIT BREAKER PANELBOARD LOCATED OUTDOORS

- A. Circuit breaker panelboard shall be dead front safety type equipped with circuit breakers and integral SPD. The 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 shall have current and voltage ratings and number of phases, poles and wires as indicated on the Drawings.
- B. Panelboard enclosures shall be fabricated from code gauge steel and constructed in accordance with UL 50 requirements.
- C. All outdoor panelboard enclosures shall be surface mounted, fabricated from cold-rolled steel, thoroughly cleaned and then coated on all sides with rust-inhibiting primer and finished with the appropriate number of coats of ANSI-49 or ANSI-61 light gray baked-on enamel paint. Each panelboard shall have an outer door and an inner door both equipped with a locking handle requiring a milled key. Furnish two (2) keys for 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. Outdoor panelboard enclosures shall be NEMA Type 3R, door-in-door.
- D. Alternate Bid No. 1: The enclosure for outdoor main panelboard, “MDP”, shall be NEMA Type 4X, door-in-door fabricated from Type 304 stainless steel in lieu of NEMA Type 3R painted steel.
- E. Both side gutters in the enclosure for outdoor main panelboard, “MDP”, shall be sized to provide a minimum of 6.5 inches of wire-bending space to accommodate termination of up to size 500 KCM conductors on the 250 amp frame branch feeder circuit breakers. Side gutters in all other panelboard enclosures and top and bottom gutters in all panelboard enclosures shall comply with the requirements of NEC 408.55 for the size of conductors to be terminated as indicated on the Drawings.
- F. A framed circuit 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.
- G. 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 are not acceptable.
- H. All bus bar conductors (phase, neutral, and ground) shall be fabricated from 1000 A/in² 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, shall meet the requirements of ASTM Specifications B 187, and shall be sized in

accordance with Underwriters' Laboratories Standards. Neutral bus bar conductors shall be insulated from the panelboard and shall be the same size as the phase bus bar conductors.

- I. Bus bars shall extend the full height of the available space for mounting future circuit breakers.
- J. The panelboard interior shall be provided with a copper ground bus bar conductor, equal to at least 25% ampacity of the phase bus bar conductors, which shall be bonded to the panelboard enclosure.
- K. 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.
- L. The neutral bus bar and the ground bus bar shall not be electrically bonded together.
- M. 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.
- N. Provide UL listed main lugs rated for a minimum temperature of 75°C and sized to allow terminating the quantity and size of stranded copper conductors indicated on the Drawings.
- O. 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.
 - 1. All branch circuit breakers 125 amps and larger must be provided with an adjustable instantaneous and adjustable long time trip feature.
- P. 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.
- Q. Circuit breakers shall have a minimum short-circuit interrupting capacity of 22 kA RMS symmetrical amperes. Do not order 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.
- R. Circuit breakers shall include factory installed mechanical lugs that are UL listed to accept stranded copper conductors. 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.
- S. Circuit breakers lugs shall be sized to accept the following size copper conductors:

Circuit Breaker Frame Size	Maximum Number and Size of Stranded Copper Conductors per Phase
15 to 20	(1) #10
25 to 35	(1) #6
40 to 60	(1) #4
70 to 110	(1) #1/0
125 to 225	(1) #250 KCM
250 to 300	(1) #350 KCM

350 to 400	(1) #600 KCM
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- T. Provide spare circuit breakers as indicated on the Drawings.
- U. Single-pole circuit breakers in 120/240V panelboards having 15 or 20 ampere ratings shall be UL Listed as Switching Duty (SWD) rated.
- V. Circuit breakers protecting circuits supplying heating, ventilation or air conditioning equipment shall be UL Listed as HACR type.
- W. All wiring terminals for conductors leaving the panel shall be designed to be used with either copper or aluminum conductors.
- X. 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, left to right, top to bottom, front to back as viewed from the front of the panelboard.
- Y. 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 blanking devices.
- Z. 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.

AA. Integral Surge Protective Device (SPD):

1. SPD shall be UL 1449 labeled with a minimum Surge Current Capacity Rating of 120kA per mode and 240kA per phase and a 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 242.10.
2. 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.
3. SPD shall be UL 1449 labeled with 20kA I-nominal (In).
4. Suppression components shall be heavy duty, thermally protected, 50kA MOVs.
5. SPD shall provide surge current paths for all modes of protection: L-N, L-G, N-G, and L-L for 120/240V, 1-phase, 3-wire systems.
6. SPD shall be integral to the panelboard and shall be connected to the panelboard bus bars through a 2-pole branch circuit breaker within the panelboard that has an ampere rating as required by the manufacturer.
7. SPD shall meet or exceed the following criteria:

- a. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

<u>Nominal Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>
120/240V, 60Hz	500V	600V	500V	800V

- b. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

<u>Nominal Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>
120/240V, 60 Hz	150V	150V	150V	300V

8. SPD shall have UL 1283 EMI/RFI filtering with active tracking up to 50dB from 10kHz to 100MHz.
 9. SPD 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.
 10. Environmental Conditions:
 - a. Operating temperature: -4°F to 122°F
 - b. Relative humidity: 5 – 95%, non-condensing
 11. SPD shall be furnished by the same manufacturer as the panelboard and circuit breakers.
 12. 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.
- BB. 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 rating.
- CC. All panelboards shall be built in accordance with and to meet the requirements of the applicable sections of the National Electrical Code, NEMA Publication PBI, OSHA and applicable UL standards. All panelboards shall bear the Underwriters' Laboratories (UL) label of approval.
- DD. Circuit breaker panelboards shall be:
1. ABB ReliaGear
 2. Eaton Type PRL4X
 3. Square D I-Line Series
- EE. All panelboards and enclosed circuit breakers, under Specification Section 262816.13 – Enclosed Circuit Breakers, shall be provided from the same manufacturer.

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 welds, scars, and abrasions; remove metal splatter, rust, and all foreign materials; and apply an organic zinc-rich coating of the following manufacture:
 - 1. Carboline SP676
 - 2. Cook 920-A-171
 - 3. Koopers' Organic Zinc
- E. Panelboards inside the cave shall be installed inside the power/control panels provided under Section 260943.23 - Relay-Based Lighting Controls.
- F. Outdoor mounted panelboards with enclosure less than 5'-10" in height shall be mounted with the top of the enclosure at 6'-0" above the concrete equipment pad as indicated on the Drawings on U-channel structural supports in accordance with Specification Section 260529 – Hangers and Supports for Electrical Systems.
- G. Outdoor mounted panelboard with enclosure that is 5'-10" or taller shall be mounted on a level, 4" high concrete pad that is 2" larger than the panelboard enclosure all around in accordance with Section 260500-3.8 - Equipment Pads and Anchor Bolts.
- H. 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 feet, 7 inches above grade, including the height of the equipment pad if one is installed, for compliance with NEC 404.8(A).
- I. All rigid metal conduits which terminate at panelboards located outdoors 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.
- J. Adjust the interior such that the dead front fits securely over all of the circuit breakers and there are no gaps or spaces.
- K. Provide blank filler plates for all unused spaces in all panelboards.
- L. *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.
- M. Remove rust from all scratches on panelboard enclosures and covers and touch-up the paint finish using manufacturer provided touch-up paint in an aerosol spray can.
- N. Perform insulation tests on each phase and verify low-resistance ground connections on equipment ground bus.
- O. Set all adjustable circuit breakers to the settings indicated in the protective device coordination study report provided under Section 260573 - Protective Device Coordination Study and Arc Flash Risk Assessment.
- P. Reset SPD surge counter in each panelboard that is provided with an SPD to zero (0).

3.2 IDENTIFICATION

- A. Each panelboard shall have a laminated plastic nameplate, with engraved black characters on a white background, on the outside surface of the door engraved with the 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 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 typewritten or printer generated to identify the load fed by each circuit for compliance with NEC 408-4 and then laminated with clear plastic to protect it from moisture.

3.4 ARC FLASH HAZARD WARNING LABEL

- A. Provide arc flash hazard warning label on exterior door of all panelboards in accordance with arc flash risk assessment study report provided under Section 260573 - Protective Device Coordination Study and Arc Flash Risk Assessment.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

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 ground fault circuit interrupter (GFCI) receptacles and while-in-use weatherproof covers 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 260533.16 – Boxes for Electrical Systems
- D. Section 260553 – Identification for Electrical Systems
- E. Section 260583 – Wiring Connections

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for each of the following:
 - 1. Ground fault circuit interrupter receptacles
 - 2. While-in-use weatherproof covers for duplex GFCI receptacles

PART 2 - PRODUCTS

2.1 GFCI RECEPTACLES

- A. Receptacles identified on the Drawings with the symbol "GFCI" shall be extra heavy duty industrial grade, tamper resistant, weather resistant, corrosion resistant, self-testing ground fault circuit interrupter, having nickel plated brass power and ground contacts with binding terminal screws for back and side wiring with solid or stranded copper conductors up to size 10 AWG, yellow nylon face with high impact polyester housing, device mounted "TEST" and "RESET" push buttons, solid green power indicator, solid red GF/Trip indicator, flashing red end-of-life indication, and with differential current sensing device capable of detecting ground fault currents of 5 milliamps, plus or minus 1 milliamp with conformal coated printed circuit board, and interrupt supply circuit within the UL trip time curve. Mounting strap assembly shall be nickel plated brass, approved for grounding, with stainless steel mounting screws and stainless-steel auto self-grounding clip. Maximum continuous operating temperature shall be $\geq 66^{\circ}\text{C}$. Dielectric withstand voltage shall be $\geq 1.5\text{kV}$. Short circuit current rating shall be $\geq 10\text{kA}$.
- B. GFCI receptacles shall be duplex, 20 amperes, 125 volts AC, 2-pole, 3-wire grounding, straight blade, NEMA 5-20R configuration meeting UL 498, UL 943, NEMA WD-6 and complying with all National Electrical Code (NEC) requirements for GFCI receptacles, TR and WR resistance,

UL E41978 Federal Spec listed and labeled; Hubbell GF5362SGYEL or approved equal by Arrow-Hart or Leviton.

- C. GFCI receptacles shall comply with all National Electrical Code (NEC) requirements for GFCI receptacles.
- D. All receptacles shall meet Federal Specification W-C-596 and shall be UL listed and labeled.

2.2 WHILE-IN-USE WEATHERPROOF COVERS FOR DUPLEX GFCI RECEPTACLE

- A. Weatherproof covers for duplex GFCI type receptacle located outdoors or inside the cave shall be UL Listed for wet location (raintight) use with utilization equipment attachment plug inserted into the receptacle.
- B. Cover door shall be spring loaded, self-closing type and the cover shall be designed for installation on a vertically mounted Type FD box housing a duplex GFCI receptacle.
- C. Cover shall be provided with weatherproof gasket and shall have one stainless steel attachment screw in each corner.
- D. Cover shall be cast aluminum with powder coated gray finish.
- E. Cover shall be NEMA 3R rated and shall meet or exceed the extra duty rating of UL 514D and shall comply with NEC 406.9(B).
- F. While-in-use weatherproof covers for duplex GFCI receptacle shall be Hubbell WP26E or approved equal by Appleton Electric, Eaton Crouse-Hinds, Killark, or O-Z/Gedney.
- G. All wiring device cover plates shall meet NEMA and ANSI Standards and UL File E91963 – Guide QCDX and Federal Specification WP-455A.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. GFCI receptacles shall be mounted vertically so that the U-shaped grounding slot is at the TOP.
- B. The white neutral conductor shall always be connected to the "white" wire or "silver" colored terminal (large slot) of the receptacle.
- C. The grounding yoke of all GFCI receptacles shall be firmly connected to the device box.
- D. Do not feed through outlets. Provide wiring pigtails on all receptacles.
- E. Mounting heights for all GFCI receptacles shall be as indicated in Section 260500 – Common Work Results for Electrical.

3.2 CIRCUIT IDENTIFICATION

- A. Cover plates for all GFCI receptacles shall be marked on the outside surface of the cover plate with a printer generated peel and stick label in accordance with Section 260553 – Identification for Electrical Systems with the source panelboard designation and circuit number.

3.3 TESTING

- A. All GFCI receptacles shall be tested for correct wiring, polarity and ground fault protection operation.
- B. Malfunctioning Devices: Repair or replace and retest. Repeat procedure until all units operate properly.

END OF SECTION 262726

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

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 10% spare fuses (minimum of 3) for each size and type of fuse used on this project, including control fuses and lighting fixture fuses.

PART 2 - PRODUCTS

2.1 250-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 shall be as manufactured by the Cooper Bussmann Manufacturing Division of Eaton or approved equal by Mersen or Littlefuse.
- D. Control circuit fuses (less than 5 amps) and associated fuse holders shall be as shown on the Drawings.

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 262816.13 – ENCLOSED CIRCUIT BREAKERS

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 enclosed circuit breakers 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

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for each type and size of enclosed circuit breaker used on this project, including information on the electronic trip unit.
- B. Provide dimensioned outline drawing for circuit breaker enclosures.

1.5 REFERENCED STANDARDS

- A. National Electrical Code: Articles 230, 240, 312, and 404
- B. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations
- C. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

1.6 LISTING REQUIREMENTS

- A. Enclosed circuit breakers shall be UL Listed and Labeled as service entrance equipment.

PART 2 - PRODUCTS

2.1 ENCLOSED CIRCUIT BREAKERS

- A. The main circuit breaker for new electrical services shall have the following ratings:

1. Type: Molded case thermal magnetic
2. Frame size: 400A
3. Rating plug: 400A
4. Continuous current rating: 80%
5. Electronic trip unit: Long time, short time and instantaneous trip settings
6. Short circuit rating: 22kA

Do not order enclosed circuit breakers 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.

- B. Terminal lugs shall be sized for up to one (1) 500 kcmil conductor on the line and load side of the circuit breaker, shall be Underwriters' Laboratories (UL) listed as being suitable for copper or aluminum 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.
- C. Provide full rated isolated copper neutral bus within the circuit breaker enclosure with lugs for connection of one (1) 500 kcmil copper incoming and one (1) 500 kcmil copper outgoing neutral conductor.
- D. Provide 100A rated copper equipment ground bus within the circuit breaker enclosure, bonded to the enclosure, with lugs for connection of one (1) 3/0 copper equipment grounding conductor, a 3/0 copper main bonding jumper and a 3/0 copper grounding electrode conductor.
- E. Circuit breaker enclosures shall be NEMA Type 3R without knockouts for outdoor locations and shall have a full hinged cover.
- F. 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.
- G. Alternate Bid No. 1: All outdoor enclosed circuit breaker enclosures shall be NEMA Type 4X fabricated from Type 304 or 316 stainless steel in lieu of NEMA Type 3R painted steel.
- H. All enclosures shall meet UL Standard 498 and shall be UL listed and labeled.
- I. Circuit breaker enclosures shall be sized as required to provide enough air space around the circuit breaker for proper cooling in an outdoor ambient temperature of up to 104°F.
- J. The minimum wire-bending space at terminals and the minimum gutter space within circuit breaker enclosures shall be as required per NEC 312.6 for (1) 500 KCM conductor per terminal on both the line and load side of the circuit breaker.
- K. Circuit breaker enclosures shall be UL labeled as “suitable for service entrance”.
- L. Provide weather and UV resistant label “MAIN SERVICE DISCONNECT” on outside front door of the circuit breaker enclosure.
- M. The circuit breaker operating handle shall physically indicate the ON and OFF positions of the breaker. The 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.

- N. The enclosure door shall be mechanically interlocked with the circuit breaker operating handle to prevent opening the door when the circuit breaker is in the ON position.
- O. Enclosed circuit breaker approved manufacturers are:
 - 1. Square D PowerPact M with Micrologic 5.0 electronic trip unit
 - 2. Approved equal by ABB
 - 3. Approved equal by Eaton
- P. Before ordering the SE rated enclosed main circuit breaker or the ATS specified in Section 263623 - Automatic Transfer Switches, verify with ATS manufacturer that the SE rated enclosed main circuit breaker will provide the required 22 kA RMS symmetrical withstand and closing rating for the ATS.
- Q. All enclosed circuit breakers and panelboards, under Specification Section 262416 – Panelboards, shall be provided from the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide separately enclosed main circuit breaker at each service entrance location.
- B. Mount outdoor enclosed main circuit breaker on U-channel supports in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.
- C. Remove rust from all scratches on circuit breaker enclosures and covers and touch-up the paint finish using manufacturer provided touch-up paint in an aerosol spray can.
- D. Set all adjustable circuit breakers to the settings indicated in the protective device coordination study report provided under Section 260573 - Protective Device Coordination Study and Arc Flash Risk Assessment.

3.2 IDENTIFICATION

- A. Mounted on the outside surface of each enclosure circuit breaker door shall be a three-layer engraved laminated plastic nameplate meeting the requirements of Section 260553 – Identification for Electrical Systems.

3.3 ARC FLASH HAZARD WARNING LABEL

- A. Provide arc flash hazard warning label on exterior door of all enclosed circuit breakers in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

END OF SECTION 262816.13

SECTION 263213.13 – DIESEL-ENGINE-DRIVEN GENERATOR SET

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 one new indoor diesel-engine-driven generator set, along with all appurtenances, as specified herein and as shown on the Drawings, to provide 10-second start emergency standby power for the Visitors Center and Onondaga Cave at the Onondaga Cave State Park.

1.3 RELATED SECTIONS

- A. Division 3 – 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 260583 – Wiring Connections
- H. Section 263236 – Resistive Load Banks
- I. Section 263613 – Non-Automatic Transfer Switches
- J. Section 263623 – Automatic Transfer Switches

1.4 SECTION INCLUDES

- A. The work covered under this section shall include, but not be limited to, the following items:
 - 1. Packaged diesel-engine-driven generator system with unit-mounted radiator and fan
 - 2. Critical exhaust silencer and stainless-steel flex
 - 3. Generator control panel
 - 4. Remote annunciator panel
 - 5. Batteries and battery charger
 - 6. Fuel oil tank with spill containment basin
 - 7. Seismic spring vibration isolators
 - 8. Remote emergency stop push button and enclosure assembly
 - 9. Lubrication oil and permanent antifreeze, including corrosion inhibitor
 - 10. Off loading of equipment at point of delivery
 - 11. Concrete foundation pad
 - 12. Outdoor installation

13. Diesel fuel for startup and operation of diesel-engine-driven generator set prior to substantial completion of the project
14. One lot of spare filters for the diesel-engine-driven generator set
15. On site startup and load testing of the diesel-engine-driven generator system
16. On site Owner training on the diesel-engine-driven generator system

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, etc.
 2. Technical data sheet(s) identifying the make and model of the engine and generator 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 internal wiring diagrams for engine, generator, control panel, battery charger, fuel oil tank and remote annunciator
 5. Manufacturer's catalog cut sheets of all auxiliary components such as electronic governor and actuator, voltage regulator, vibration isolators (including mounting diagram), batteries, battery rack, exhaust silencer, exhaust flex, jacket water heater, radiator and fan
 6. Dimension drawings (plans and elevations) showing overall measurements, mounting locations, and interconnect point for electrical connections, fuel, exhaust, cooling and drains.
 7. Interconnecting wiring diagrams and schematics for complete emergency system, including generator, main line circuit breaker and resistive load bank circuit breaker, fuel tank, battery charger, fuel system and remote alarm indications. These drawings shall be specific to the project component requirements and provided by the equipment manufacturer or the authorized dealer. Factory drawings that provide multiple interconnections for items not specific to the project will be rejected.
 8. Engine mechanical data at varying loads up to full load, including heat rejection, exhaust gas flows and back pressure, combustion air and ventilation air flows, noise data, fuel consumption rate curves at various loads, cooling capacity (maximum ambient condition), etc.
 9. Exhaust system calculations, in order to verify that the exhaust system does not violate the constraints of the generator maximum exhaust backpressure value
 10. Certificates for compliance with EPA Emissions Standards for Compressed Ignition Engines
 11. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor
 12. Engine and generator combination transient report at rated power factor for specific model supplied, of voltage and frequency transients response including recovery time at 50, 75 and 100% load application
 13. Generator resistances, reactances and time constants
 14. Generator current decrement curve
 15. Generator motor starting capability
 16. Generator thermal damage curve
 17. Jacket water heater connection diagram

18. Control panel schematics
 19. Oil sampling analysis, laboratory location, and information
 20. Emissions data, including emissions limits from referenced codes versus engine nominal emissions.
 21. Fuel oil tank and fuel transfer system, including all accessories
 22. Concrete pad recommendation, layout and stub-up locations for electrical connections
 23. Diesel-engine-driven generator set sample test report
 24. Manufacturer's and dealer's written warranty disclosure statement for the period specified
 25. Location and description of supplier's parts and service facility within a two (2) 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. Submit information and pricing on diesel-engine-driven generator manufacturer's preventive maintenance contract options and extended service contract options. Preventive maintenance contract information shall clearly indicate the terms, conditions and cost of the contract, the frequency of preventive maintenance visits and all items to be tested, inspected, checked, etc. on each visit.
- D. Extended service contract information shall clearly indicate the terms, conditions and cost of the contract, the length of the contract, any items not covered under the contract and the per visit deductible cost if applicable. Pro-rated type extended service contracts are not acceptable.
- E. Authorized distributor shall provide copies of technician's factory training certificates specific to the proposed product on engine overhaul and 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. Major engine and control parts shall be available within 24 hours from the time a component is deemed defective.
- F. Operation & Maintenance Manuals: 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.
- G. Submit operation and maintenance data under the provisions Section 260500 – Common Work Results for Electrical.
- H. 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 on a CD.
 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 DIESEL-ENGINE-DRIVEN GENERATOR 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, and fuel 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
- I. 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 AB 1 – Molded Case Circuit Breakers
 - 3. ANSI/NEMA MG 1 – Motors and Generators
 - 4. ANSI/NEMA MG2 – 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. NFPA 30 – Flammable and Combustible Liquid Code
 - 9. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines
 - 10. NFPA 101 – Life Safety Code
 - 11. NFPA 110 – Emergency and Standby Power Systems
 - 12. UL 142 – Steel Above Ground Tanks for Combustible Liquids
 - 13. UL 486A – Safety Wire Connections and Soldering Lugs for Use with Copper Conductors
 - 14. UL 508 – Standard for Industrial Control Equipment
 - 15. UL 508A – Industrial Control Panels
 - 16. UL 2200 – Stationary Diesel Engine Generator Assembly, 600 Volts Maximum
 - 17. Environmental Protection Agency (EPA) Emission Standards for Large Stationary Diesel and All Stationary Dual-fuel Engines, EPA AP42.
 - 18. Code of Federal Regulations 40 CFR Part 60, Subpart III – Standards of Performance for Stationary Compression Ignition Combustion Engines
 - 19. Code of Federal Regulations 40 CFR Part 89 Subpart B – Emission Standards and Certification Provisions
 - 20. Missouri Code of State Regulations 10 CSR 10 – 6.020 Definitions and Common Reference Tables

- B. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the diesel-engine-driven generator set, 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 the provisions of Section 260500 – Common Work Results for Electrical.
- B. Accept packaged diesel-engine-driven generator set and accessories on site and document any and all damage upon receipt at the project site.
- C. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.
- D. The diesel-engine-driven generator shall be delivered by truck to the project site, Onondaga Cave State Park, Leasburg, Missouri, where it shall be inspected for shipping damage, off-loaded and moved into place for final installation.
- E. Final timing of equipment delivery shall be coordinated by the Contractor to suit the construction schedule.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit record documents in accordance with the requirements of Section 260500 – Common Work Results for Electrical.
- B. Accurately record location of diesel-engine-driven generator and all electrical connections.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in packaged diesel-engine-driven generator systems with minimum twenty-five (25) years documented experience.
- B. To qualify as a manufacturer, the engine must be the principal item manufactured and the complete diesel-engine-driven generator set shall be supplied by that manufacturer's authorized distributor only.
- C. Supplier: Local authorized distributor of diesel-engine-driven generator manufacturer for the equipment supplied.
- D. The diesel-engine-driven generator set supplier must maintain a full parts and service center within one hundred (100) miles of the project site and shall maintain 24-hour parts and service capability. The distributor shall stock parts as needed to support the generator set package for this project and shall maintain an adequate staff of factory trained service personnel.

1.10 WARRANTY

- A. The standby diesel-engine-driven generator and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of 5 years from the date of substantial completion of the project in accordance with Article 3.4 of Section 007213 – General Conditions with a 2,500-hour term. 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 diesel-engine-driven generator manufacturer's requirements as published in the O&M Manuals.
- C. Accessories such as silencer, fuel tank, and battery charger shall be warranted for a minimum period of 1 year from the date of substantial completion of the project in accordance with Article 3.4 of Section 007213 – General Conditions.
- D. Satisfactory warranty documents must be provided. Authorized distributor shall provide copies of factory authorization warranty repair certificates specific to the proposed product on engine overhaul and 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.

1.11 EXTRA MATERIALS

- A. Provide five (5) spare indicator lamps of each size and type, if the equipment provided has any user replaceable indicator lamps.
- B. Provide three (3) spare fuses of each size and type.
- C. Provide one (1) complete set of spare filters for the diesel-engine-driven generator set.

1.12 FACTORY TESTS

- A. The diesel-engine-driven generator manufacturer shall perform all standard tests as required by NEMA, after the fabrication is complete and before shipping from the factory. Test runs shall be made over the full design load range. Any defects that become evident during these tests shall be corrected before shipping. A copy of the actual tests performed on this unit, including the results obtained, shall be designated as the "Test Report", and shall be submitted to the Designer for review and approval prior to shipment of the diesel-engine-driven generator set to the project site, and also shall be included as a part of the equipment O&M Manuals.
- B. Completely assembled engine, generator, and lubrication system shall be spin tested at the factory. The spin test shall check rotation, vibration, temperatures, oil leaks, engine trip devices and general operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all requirements specified herein, provide products by one of the following:
 - 1. Caterpillar
 - 2. Cummins
 - 3. Kohler
- B. The design of the diesel-engine-driven generator installation has been based on a Caterpillar Model C4.4GC diesel-engine-driven generator set. Should the Contractor choose to provide equipment

from one of the approved equal manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories.

2.2 GENERAL

- A. The packaged diesel-engine-driven generator set shall be a coordinated assembly of compatible components.
- B. The diesel-engine-driven generator set shall be a diesel-electric generator consisting of one liquid-cooled diesel engine directly coupled to one alternating current (AC) generator, mounted on a common rigid base consisting of cross-braced steel structural members.
- C. All 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.
- D. Safety Standard: Comply with ASME B15.1.
- E. The diesel-engine-driven generator set shall have a rated output for standby service of 50ekW, 50 kVA at 1.0 power factor, including radiator fan and all parasitic loads, 120/240 volts, 1-phase, 3-wire, 60 hertz. The diesel-engine-driven generator set shall operate at a speed of 1800 revolutions per minute (RPM).
- F. Design parameters:
 - 1. Site elevation..... 683 ft.
 - 2. Site Design air temperature range..... -10°F to 110°F
 - 3. Maximum starting voltage dip..... 25%
 - 4. Maximum generator winding temperature rise..... 105°C
 - 5. Duty Standby
 - 6. Fuel No. 2 ULSD Diesel
 - 7. Frequency..... 60 Hz
 - 8. Generator speed 1800 RPM
 - 9. Voltage..... 120/240V, 1-phase, 3-wire connected
 - 10. Power factor..... 1.0
 - 11. Location Outdoors
 - 12. Maximum exhaust system pressure at silencer outlet..... 10 inches H₂O
- G. The entire diesel-engine-driven generator assembly, as well as the means of fastening to the concrete foundation, shall be capable of withstanding seismic loads. The International Building Code – 2018 Edition and ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures shall be used as the design code with the specific environmental factors as stated below:
 - 1. Earthquake Design Data:
 - a. Seismic Importance Factor: $I = 1.0$
 - b. Occupancy Risk Category: II
 - c. Mapped Spectral Response Accelerations: $S_s = 0.351$, $S_1 = 0.154$
 - d. Site Class: B
 - e. Spectral Response Coefficients: $SDS = 0.234$, $SD1 = 0.102$
 - f. Seismic Design Category: B
 - g. Component Amplification Factor: $A_p = 1.0$
 - h. Component Response Modification Factor: $R_p = 2.5$

- i. Overstrength Factor: $\Omega_o = 2.0$
 - j. Analysis Procedure: Equivalent Lateral Force per ASCE 7-16 Section 13.3
- H. The diesel-engine-driven generator set shall be mounted on a rigid structural steel sub-base which shall provide adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the diesel-engine-driven generator set center of gravity.
- I. Suitable seismic vibration isolators located between the diesel-engine-driven generator set and the rigid sub-base shall be provided. The vibration isolators shall consist of elastomeric rubber isolation pads located between the engine-generator and the and the steel mounting frame.
- J. The quantity and size of the vibration isolators shall be as recommended by the manufacturer, and in general, shall be spaced approximately four (4) feet apart along the length and width of the diesel-engine-driven generator set.
- K. The diesel-engine-driven generator set shall be capable of starting and reaching rated voltage and frequency in a maximum time of 10 seconds and shall meet all requirements of NFPA-110, latest edition for a Level 2, Type 10, Class 24 emergency power supply (EPS).
- L. Power rating of the diesel-engine-driven generator set shall be based on operation at rated RPM when equipped with all necessary operating accessories such as air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pumps, jacket water pump, governor, alternating current generator, exciter regulator, and radiator fan. Rating shall apply at site conditions of 683 ft. above sea level and 122°F (50°C) ambient air temperature. The design air temperature range shall be from -20°F to +122°F.
- M. 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. The generator nameplate shall indicate all standard information as required by NEMA. The generator nameplate shall also indicate the maximum line-to-line and line-to-ground RMS symmetrical ampere fault capability at the rated voltage of the generator.
- N. Furnish a complete and coordinated control system which provides all necessary interfaces between the diesel-engine-driven generator, and the generator auxiliaries. All necessary switches, starters, contactors, and overloads required for the generator auxiliaries shall be furnished.
- O. The diesel-engine-driven generator set shall also meet the following requirements:
- 1. The rated output voltage of 240 volts (line-to-line) shall have a manual adjustment of $\pm 5\%$.
 - 2. Voltage regulation shall not exceed $\pm 0.5\%$.
 - 3. Voltage steady-load bandwidth shall not exceed $\pm 1\%$.
 - 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 $\pm 0.5\%$ 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.
- P. The diesel-engine-driven generator shall consist of the following major components:
1. Diesel engine
 2. Electric generator
 3. Generator control panel
 4. Radiator with fan
 5. Exhaust silencer (muffler)
 6. Battery(ies) and battery charger
 7. Fuel tank
 8. Fuel transfer (between fuel tank and engine) system
 9. Remote annunciator
 10. Generator enclosure mounted emergency stop push button and enclosure
 11. Remote emergency stop push button and enclosure
- Q. The diesel-engine-driven generator manufacturer shall design the controls for the entire emergency system, which shall encompass the diesel-electric generator set and the generator control panel.
- R. The diesel-engine-driven generator manufacturer 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 or contacts necessary to achieve this.

2.3 THEORY OF OPERATION

- A. The automatic transferring of all Visitors Center and Onondaga Cave electrical loads from the normal power source to the emergency generator power source shall be accomplished by means of a new 400A automatic transfer switch, as specified in Section 263623 – Automatic Transfer Switches, located outdoors near the emergency generator.
- 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) RUN (MANUAL), (2) OFF/STOP, and (3) AUTOMATIC.
- 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 (adjustable “on delay” set for 3 seconds) located inside each of the automatic transfer switch 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 automatic transfer switch shall automatically transfer the load from the normal (utility) source to the emergency generator.
 2. Upon restoration of normal power (when the normal voltage is greater than 90% of rated voltage in both phases), the automatic transfer switch shall, after an adjustable 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 diesel-engine-driven 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 RUN (manual) position:
 - 1. The diesel-engine-driven generator set will automatically start immediately and come up to rated voltage and frequency. The diesel-engine-driven generator set shall then be manually controlled and shall continue to operate until the Engine Control Switch is turned to the OFF/STOP or AUTOMATIC position.
- E. The OFF/STOP position of the Engine Control Switch shall shut down the diesel-engine-driven 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 generator circuit breakers and shut down the diesel-engine-driven generator set immediately without a cool-down time period.
 - 2. The generator enclosure mounted, and remote mounted, EMERGENCY STOP push buttons, when depressed, shall perform this same function.

2.4 ENGINE

- A. The generating set drive shall be an inline or V-type, four-stroke-cycle, diesel fueled, electric ignition, internal combustion engine, liquid-cooled with a unit mounted radiator, fan, and water pump(s).
- B. Rating: Standby
- C. Engine Speed: 1800 RPM
- D. It shall be the responsibility of the diesel-engine-driven generator manufacturer to properly size the horsepower rating of the engine to operate properly at rated load at a speed of 1800 rpm.
- E. The engine shall be a compression ignition diesel and shall perform in accordance with all specifications and all applicable EPA emissions standards when operating on No. 2 Diesel fuel oil that complies with current Federal Regulation requirements for Ultra Low Sulfur Diesel of 15 PPM and manufacturer's fuel requirements.
- F. Emissions: Engine shall comply with the following emissions requirements.
 - 1. Code of Federal Regulations 40 CFR Part 60, Subpart III
 - 2. 40 CFR Part 89.112
 - 3. Missouri Code of State Regulation 10 CSR 10-6.020
- G. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve.
- H. The fuel oil shall be supplied from the diesel-engine-driven generator set fuel oil tank.
- I. Lubrication System: Lubrication shall be full pressure as supplied by a gear type oil pump with strainer and thermostatic control valve capable of full flow and designed to be fail-safe. The engine shall have full flow fuel oil filter with replacement elements, fuel pumps, fuel filter, fuel

strainer, air filters, full flow lube oil cooler with automatic bypass valve, full flow lubricating oil filter of the replaceable element type having an automatic bypass valve, service meter, gear-driven water pump, and instruments, including a fuel pressure gauge, water temperature gauge, and lubricating oil pressure gauge. All filters shall be the replaceable element type. Injectors shall be fuel limited (no load limit adjustments required). Provide crankcase drain arranged for gravity drainage with siphon or pump.

- J. Engine Jacket Heater(s): Thermostatically controlled jacket water heater(s) shall be provided to maintain proper coolant temperature while the engine is OFF. The jacket water heater(s) shall be engine-mounted thermal circulation tank-type immersion water heater incorporating an adjustable thermostatic switch and shall maintain engine jacket coolant temperature in the range of 90°F to 120°F (32.2°C to 49°C) in a still air ambient temperature of -10°F (-23.3°C). The heater(s) shall be 120 or 240-volt, single-phase, 60 Hz with output rating as recommended by the engine manufacturer and shall be automatically turned OFF when the engine is operating. V-type engines shall have one heater per each bank of cylinders. Provide a shut-off valve for each heater to allow for replacement of the heater without draining the entire coolant system.
- K. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on diesel-engine-driven generator set mounting frame and integral engine-driven coolant pump.
1. The radiator shall have a vibration-free mounting, filler cap with pressure valve and vacuum valve, and a coolant system drain. The drain connection shall be at the lowest point in the cooling system. Drain piping shall be provided in accessible locations on the side of the base frame to permit complete draining of the entire cooling system.
 2. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature at full rated load in a maximum ambient temperature of 122°F based on 50/50 extended life coolant/water mixture.
 3. Radiator and blower shall be provided to accommodate an airflow restriction external to radiator of 0.5 inches of water (pressure drop through intake and exhaust louvers and ductwork).
 4. A safety guard shall be provided for the fan, belt and pulleys.
 5. Coolant: Solution of 50 percent Extended Life Coolant (ELC) and 50 percent water, with anti-corrosion additives. 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.
 6. Provide expansion tank with site glass and low coolant level sensor.
- L. Governor: Engine speed shall be governed by a Woodward Model 2301A electronic, speed sensing, isochronous governor speed control, ADEM A4 Electronic Control Module or approved equal by the engine manufacturer. The engine governor shall maintain isochronous frequency regulation from no load to full rated load with hydraulic or hydro-electronic actuation. Steady-state operating band shall be ± 0.2 Hz. The governor shall be capable of remote speed adjustment. The moving parts of the governor shall be automatically lubricated.
- M. If the diesel-engine-driven generator manufacturer's design requires a hydraulic actuator it shall be a Woodward Model EGB or approved equal hydro-electronic actuator by the engine manufacturer. Size of actuator shall be based on work output required.
- N. Engine Starting: 12 or 24-volt DC starting system with positive engagement drive of sufficient capacity to crank the engine at a speed which will start the engine under unfavorable operating conditions. One or two starter motors shall be provided in accordance with manufacturer's requirements. The starting pinion will disengage automatically when the engine starts. The starting system shall incorporate an automatically reset circuit breaker for anti-butt engagement. Include

remote starting control circuit, with RUN-OFF/STOP-AUTOMATIC selector switch on the Generator Control Panel.

- O. Battery-Charging Alternator: 12V or 24V, 45A battery-charging alternator, factory mounted on engine with solid state voltage regulation.
- P. All wiring on the engine shall be rated for use in high ambient temperature areas, shall be harnessed or flexibly enclosed, shall be securely mounted on the engine to prevent chafing and vibration damage, shall terminate at the control panel in an enclosed box or panel and shall be connected to engine mounted devices at a junction box or through plug-in connectors.
- Q. The engine shall have pre-alarms provided for ENGINE (jacket water) LOW TEMPERATURE, LUBE OIL LOW PRESSURE, and ENGINE (jacket water) HIGH TEMPERATURE in accordance with NFPA 110. Safety shutoffs for ENGINE HIGH WATER TEMPERATURE, LOW OIL PRESSURE, ENGINE OVERSPEED, and ENGINE OVERCRANK shall be provided. Limits for pre-alarms and alarms shall be selected by the engine manufacturer.
- R. Digital engine monitoring shall be provided for the following items as part of the Generator Control Panel specified elsewhere in this Section.
 - 1. Engine lubrication (lube) oil pressure
 - 2. Engine coolant temperature
 - 3. Engine running time (hours)
 - 4. Engine revolutions per minute (RPM)
- S. Exhaust System: Critical type silencer with minimum 30 dBA attenuation and with single or dual bottom inlets, muffler companion flanges, and flexible stainless steel exhaust fittings, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions.
 - 1. Silencer shall be welded, heavy duty carbon steel, radial pancake type with 2 inches of compressed thermal acoustical insulation inserted between the double shell construction of the silencer, support lugs, ANSI Class 150 flanged connections, and a threaded opening for connection of 3/4" drain line. Opening shall be flush on inside of silencer.
 - 2. Silencer shall be engine-generator set manufacturer's standard offering.
 - 3. Exhaust flexible fittings shall be suitably sized stainless steel flexible bellows.
- T. The following diesel engine accessories shall be included.
 - 1. Exhaust driven turbochargers(s) or supercharger as applicable
 - 2. Aftercoolers, if required
 - 3. Exhaust silencer and stainless-steel expansion joint(s) or flexible connectors
 - 4. Intake air silencer as required
 - 5. Dual element air intake filters
 - 6. Stainless steel expansion joint or flexible connection for turbocharger air intake, if offered
 - 7. Starting battery charging alternator
 - 8. Engine coolant water expansion tank or steel pipe, if required
 - 9. Coolant water radiator with cooling fan(s)
 - 10. Thermostatically controlled jacket water heater(s)
 - 11. Flexible lines and connectors shall be provided for:
 - a. Fuel oil supply to engine
 - b. Fuel oil return(s) from engine
 - c. Jacket water supply

- d. Jacket water return
- 12. Fuel cutoff valves
- 13. Pumps
 - a. Fuel priming (manual)
 - b. Fuel transfer
 - c. Gear driven water
- 14. Primary duplex fuel water separator with bypass valves to provide the ability to isolate each filter independently for changing while the engine is running.
- 15. All required fuel and lubricating oil filters, strainers and accessories including, but not limited to:
 - a. Fuel filter
 - b. Fuel return cooler
 - c. Lube oil filter
 - d. Lube oil cooler
- 16. Crankcase breather
- 17. Governor actuator (if applicable)
- 18. Overcrank and overspeed sensors with contacts for annunciation and engine shutdown
- 19. Ball valves for drainage of jackets, etc., shall be provided in the intercooler and main jacket water circuits
- 20. One lot of lube and extended life coolant solutions
- 21. Engine mounted terminal panel with terminal blocks, to serve as a central wiring point for all items located at the engine
- 22. Oil Drain: A suitable drain for lubricating system shall be provided with cap and valve located to permit easy access. The drain pipe shall be extended out beyond the diesel-engine-driven generator base and rigidly supported. The drain shall be mounted a minimum of 6" above the vibration isolators.
- 23. All the required instruments and controls with all the required piping, valves and fittings.

2.5 GENERATOR

- A. The generator shall be an alternating current (AC) synchronous machine having a synchronous revolving field and a brushless exciter. The generator shall be 120/240-volt, 60 hertz, single-phase, three-wire, six-winding, 1800 RPM, single-bearing, wet wound, tropicalized, having four (4) poles and built to ANSI/NEMA MG 1 standards. The pole faces shall contain complete (full) amortisseur windings.
- B. Power Rating: The generator shall have an output electrical power (ekW) rating of 50 ekW for standby service at a power factor of 1.0 for continuous duty, with Class H temperature rise (125°C temperature rise over 40°C ambient, by resistance).
- C. Locked Rotor Motor Starting Capability: Minimum of 182.2 skVA at 30% voltage dip as defined by NEMA MG 1. Sustained voltage dip data is not acceptable.
- D. Subtransient Reactance ($X'd$): Maximum of 0.16 per unit direct axis.
- E. Enclosure: Open drip-proof self-ventilated, air-cooled, with air flow through screened louvers.

- F. Insulation: Class H insulation shall be used on the stator and rotor, and both shall be further protected with a Vacuum Pressure Impregnation (VPI) system using Class H epoxy resin, which shall provide moisture, chemical, abrasive resistance, and fungus protection on all coils.
- G. Windings: 2/3 pitch form wound stator winding that optimizes generator efficiency and minimizes total harmonic distortion, especially 5th and 7th harmonics which are detrimental to AC motors.
- H. Strip Heater: Thermostatically controlled located inside the generator housing to prevent moisture condensation by maintaining stator windings above dew point. The strip heaters shall automatically be turned OFF whenever the diesel-engine-driven generator set is in operation. Strip heaters and control shall be 120 volts AC, single-phase, 60 hertz.
- I. Harmonic Distortion: Less than 5% total harmonic distortion at rated power factor, full load voltage and RMS current. Maximum single harmonic shall not exceed 3%.
- J. Telephone Influence Factor: Less than 100 based on 1960 weightings.
- K. Rotor: Rotating field type furnished complete with a single-phase, rotating brushless AC exciter rotor and rectifier assemblies mounted on a common shaft within the generator stator frame. The generator field and exciter rotor coils shall be securely supported and held in place to prevent movement caused by electrical and rotational forces. Rotors shall be dynamically balanced with AC exciter rotor and rectifier assemblies mounted. The generator rotor shall be dynamically balanced within 0.0005-inch peak-to-peak amplitude displacements at both ends of shaft and shall sustain 25% overspeed.
- L. Exciter: Rotating Permanent Magnet Generator (PMG) pilot exciter to provide constant voltage and automatic field flashing for the generator field via the Voltage Regulator. Capacity shall be sufficient for operating the generator at rated voltage and kVA without exceeding total "hot spot" temperature. The constant output voltage from the PMG pilot exciter shall be fed to the input power terminals on the Voltage Regulator. The DC output from the Voltage Regulator shall be fed to the brushless exciter field. When the generator rotor begins to turn, the PMG rotating magnetic field shall produce a voltage in the PMG stationary armature winding. The output voltage from this PMG armature winding then shall be used to power the Voltage Regulator.
- M. The PMG shall provide "current boost capability" to the generator, thereby supporting 300% rated current for ten seconds when a short circuit occurs.
- N. The exciter AC output shall be converted to DC by means of a full wave solid-state rectifier mounted on the generator armature. All rectifier diodes shall be non-aging, metallic, hermetically sealed, silicon type. Diodes shall be carefully selected and conservatively rated for long life. Diodes shall be mounted on heat sinks to effectively dissipate diode heat.
- O. Voltage Regulator: Automatic volts-per-hertz type, solid-state or magnetic amplifier Voltage Regulator manufactured by the generator manufacturer or approved equal shall be mounted inside the Generator Control Panel or shock mounted inside the generator. Voltage regulation shall be $\pm 0.5\%$ of rated voltage from no load to full rated load, controlling the exciter field current as required to maintain a constant and stable generator output voltage. A 5% variation in frequency and the effects of field heating shall not affect the unit's regulation performance. The unit shall have frequency compensation which aids system block load pickup performance and controls excitation when operating below synchronous speed. Shorting the regulator output shall not damage the regulator.

- P. Readily accessible voltage droop, voltage level, and voltage gain controls shall be included in the voltage regulator module. The regulator shall have three phase sensing with the sensing circuit isolated from the power stage.
- Q. Electro-magnetic interference suppression shall be an integral part of the voltage regulator. Thermal protection for power semi-conductors, inherent over-voltage protection, and fuse protection for extreme overcurrent shall be provided internally in the regulator.
- R. The voltage regulator module shall include the following protective features:
1. Current limit circuits shall restrain the exciter field current while allowing full forcing voltage to be applied to obtain rapid response during transient conditions or service overloading on the generator.
 2. A time-delay circuit shall sense the overcurrent limit operation and cut off all field current to the generator after ten seconds.
- S. A Manual Voltage Control (MVC), providing a $\pm 5\%$ minimum voltage adjustment, shall be provided on the front of the Generator Control Panel.
- T. The engine, generator, regulator, and governor combination shall permit FULL RATED BLOCK LOAD application with speed and voltage recovery within six seconds after full load application.
- U. The generator shall be designed and constructed to withstand single-phase line fault currents.
- V. Generator Terminal Box: Adequately sized to allow termination of power conductors. The minimum dimensions and wire bending space within the terminal box shall meet the requirements of NEC Article 312. Generator terminal box shall be located on the right-hand side of the generator as viewed from the rear of the generator looking towards the engine.
- W. Bearings: Antifriction, regreasable or sealed type with B-10 life of 50,000 hours. Bearings shall be insulated where necessary to prevent the flow of "shaft current". Bearing housing shall be designed to prevent the entrance of lubricant into the generator enclosure, or dirt into the bearings.
- X. The generator shall have a corrosion resistant nameplate in a conspicuous location with the following minimum data:
1. Manufacturer's name and location
 2. Serial number
 3. Model/type
 4. Kilovolt-ampere (kVA) rating
 5. Kilowatt (kW) rating
 6. Power factor
 7. Time rating
 8. Temperature rise ($^{\circ}\text{C}$) for rated continuous load
 9. Rated speed in RPM
 10. Line voltage (volts AC)
 11. Rated line current in amperes AC
 12. Number of phases
 13. Frequency (hertz)
 14. Exciter field voltage (volts DC)
 15. Generator field voltage (volts DC)
 16. Engine bore and stroke
 17. Engine firing order

18. Direct Axis Subtransient Reactance, X''_d (ohms)
 19. Direct Axis Transient Reactance, X'_d (ohms)
 20. Direct Axis Synchronous Reactance, X_d (ohms)
- Y. The diesel-engine-driven generator shall be provided with a large red nameplate in a prominent location with 1/2" high white lettering stating the following:

DANGER!

**THIS IS A FULLY AUTOMATIC
EMERGENCY SYSTEM CONTROL.
ENGINE MAY START AT ANY TIME!**

**DO NOT REMOVE COVERS OR
ATTEMPT MAINTENANCE WITH
ENGINE IN AUTOMATIC MODE.**

- Z. The generator shall be manufactured by the diesel-engine-driven generator manufacturer or by:
1. Kato Engineering Company
 2. Lima Electric Co., Inc.
 3. Marathon Electric Manufacturing Corporation
 4. Magnetek Electric Co.

2.6 MAIN LINE AND LOAD BANK CIRCUIT BREAKERS

- A. The diesel-engine-driven generator set shall be equipped with a generator main line circuit breaker and a load bank circuit breaker. The breakers shall be vibration isolated mounted to the side of the generator set with the breaker line side connected directly to the generator output.
- B. The circuit breakers shall be molded case type located in a NEMA Type 1 or Type 12 surface mounted enclosure. Wire bending space within the enclosure shall meet the requirements of NEC Tables 312.6.
- C. The circuit breakers shall be rated 240 volts AC, 2-pole, and shall be UL Listed for 100% continuous load operation in accordance with NEC 215-3 (Ex. No. 1.). The main line circuit breaker shall be rated for 200A with electronic (adjustable) trip unit and the load bank circuit breaker shall be rated for 100A, thermal magnetic type. The circuit breakers shall have a minimum interrupting rating greater than the maximum fault that could be produced at the load terminals of the breaker, 22 kA minimum.
- D. The circuit breakers shall be built in accordance with Underwriters' Laboratories Standard 489, NEMA Standard AB-1 (latest revision), and Federal Specification W-C-375B/GEN, as Class 23a.
- E. The circuit breakers shall have an over-center, trip-free, toggle-type operating mechanism having quick-make, quick-break action with positive handle indication for ON, OFF, and TRIP positions. The breakers shall provide common tripping of both poles.
- F. The breakers shall be capable of operating in any position.
- G. The main line circuit breaker shall be provided with a 12 or 24VDC shunt trip device connected to the diesel-engine-driven generator safety shutdowns.

- H. The main line breaker shall be provided with a Form "C" normally open/normally closed set of auxiliary switch contacts to indicate circuit breaker open/closed position. Contacts shall be rated 10A @ 125-250 VAC.
- I. The ampacity of the factory supplied conductors from the generator output terminals to the 200A generator output circuit breaker shall be not less than 115 percent of the nameplate current rating of the generator.
- J. Mechanical, set screw type lugs, sized for the conductors as shown on the Drawings, shall be supplied on the load side of each circuit breaker.
- K. The circuit breakers shall be manufactured by:
 - 1. ABB-General Electric
 - 2. Eaton
 - 3. Square D Company
- L. Before ordering the diesel-engine-driven generator set or the ATS specified in Section 263623 - Automatic Transfer Switches, verify with ATS manufacturer that the main line generator output circuit breaker will provide the required 22 kA RMS symmetrical withstand and closing rating for the ATS.

2.7 GENERATOR CONTROL PANEL

- A. A local Generator Control Panel shall be provided for complete control and monitoring of the diesel-engine-driven generator set. Control panel shall be housed in a Type 1 or Type 12, surface mounted, dead front, 14-gauge (minimum) steel enclosure mounted inside the diesel-engine-driven generator set enclosure or mounted on the diesel-engine-driven generator set itself. Mounting method shall isolate the control panel from diesel-engine-driven generator set vibration. 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 diesel-engine-driven 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 starting circuit after eight attempts if the engine has not started within that time.
 - 3. Adjustable cooldown timer (may be included in automatic transfer switch per Section 263623 - Automatic Transfer Switches)
 - 4. Emergency Stop push button
 - 5. Three (3) position RUN-OFF/STOP-AUTOMATIC 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
 - 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 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. Sensors and individual LED pilot lights and 12 or 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
16. Audible alarm, 12- or 24-volts DC, flush mounted, 101 dB(A) at 10 feet; Edwards Type 871-G1, or approved equal
 17. Alarm Acknowledge/Horn Silence push button
 18. 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
 19. Main thermal-magnetic circuit breaker to disconnect all power within the control panel
 20. Automatic voltage regulator specified elsewhere in this Section
 21. 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 130°F, 0 to 100% condensing relative humidity environment.

2.8 REMOTE ANNUNCIATOR

- A. Provide a Remote Engine Annunciator Panel(s) in compliance with NFPA 110 for a Level 2 system with LED indicating lights and 12 VDC or 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 standard Type 1 or Type 12 painted steel enclosure. The remotely reported alarms shall include the following:

1. Generator Running
 2. Generator Breaker Open
 3. Control Switch Not In Auto
 4. Emergency Stop
 5. Lubrication Oil Low Pressure Shutdown
 6. Engine High Temperature Shutdown
 7. Engine Low Temperature Alarm
 8. Low Coolant Level Alarm
 9. Engine Overcrank Shutdown
 10. Engine Overspeed Shutdown
 11. Battery Charger Failure Alarm (includes AC failure)
 12. Low Cranking Voltage Alarm
 13. Low Fuel Level Alarm
 14. Fuel Oil Tank Leak Alarm
- B. Audible alarm shall be 12- or 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 Type 1 or Type 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 95% relative humidity environment.

2.9 BATTERY AND BATTERY CHARGER

- A. Furnish and install a 12 or 24-volt DC battery system and battery charger for the engine-generator set. Charger and batteries shall be located within the generator weatherproof enclosure.
- B. Battery(ies): The battery(ies) shall be lead-acid heavy duty storage type having electrolyte as required and as specified by the manufacturer for engine starting at jobsite conditions. The battery(ies) shall be sized and rated by the battery manufacturer in accordance with the requirements set forth by the engine manufacturer for proper starting of the engine under "worst case" conditions at an ambient temperature of 0°F but shall be rated no less than 140-ampere hours / 1000 CCA per battery. Battery(ies) shall be capable of cranking engine at rated ambient for a minimum of three minutes, based upon a 60-second cycle consisting of 30 seconds cranking time and 30 seconds rest time resulting in a total elapsed time period of 6 minutes.
- C. The minimum battery life shall be 3 years at jobsite conditions.

- D. A battery rack and necessary insulated ultra-flexible stranded copper cables and clamps shall be provided, for location alongside the engine. The positive ("+") cable shall have red colored insulation and the negative ("-") cable shall have black colored insulation.
- E. Battery cables shall be provided of adequate size to assure proper starting voltage is maintained during engine cranking. Termination of the battery leads shall be clearly marked on the power unit as "positive" and "negative." The markers shall be attached to the unit in such a manner that they will not become detached during shipment.
- F. A seismic rated battery rack assembly shall be provided. Insulating material shall be added to the battery rack assembly for isolating batteries. Battery rack shall be painted with acid-resistant paint and shall comply with NEC Article 480.
- G. Batteries shall be heavy-duty, high-rate discharge type, manufactured by Caterpillar, Exide, Gould, or approved equal.
- H. Battery charger: UL listed, solid state, 12 or 24-volt DC, fully automatic, 10 amp minimum, two-rate, full-wave rectifier, float/equalize type, housed in a Type 1 or Type 12 enclosure. Mount in a readily accessible location within the diesel-engine-driven generator set weatherproof enclosure. Charger shall have means for adjusting the high and low rates, complete with charge light and power "on" lights. Charger high rate shall be capable of recharging a discharged battery up to 100% of full capacity within 8 hours. When batteries reach full charge, charger shall automatically taper off charging current according to battery manufacturer's instructions. After battery is fully charged, charger shall automatically switch to low rate. The low rate shall be a trickle charging current sufficient to maintain batteries in a fully charged condition. Battery charger shall automatically be disconnected from the battery during the cranking period of the diesel engine and automatically reconnected to the battery immediately after cranking.
- I. Charger shall require a 120-volt, 60 hertz input, and shall maintain rated output voltage within $\pm 1\%$ from no load to full load with AC input variations of $\pm 10\%$.
- J. Provide battery temperature compensation and over temperature protection.
- K. Charger shall have a DC voltmeter (2% accuracy) and a DC ammeter (2% accuracy) mounted on the front door of the charger enclosure.
- L. Charger shall have automatic overload protection (current limiting), and fused AC input and DC output. The charger shall have a built-in alarm feature which shall sense a charger failure due to low DC battery voltage or loss of AC voltage input and shall announce such failure by activating the alarm contact. The alarm contact shall consist of a separate individual isolated normally closed contact which shall be annunciated on the local Generator Control Panel annunciator, as BATTERY CHARGER FAILURE. Include alarms per NFPA 110 for Level 2 system.
- M. Charger shall be permanently marked with the allowable range of battery unit capacity, nominal output current and voltage, and sufficient battery-type data to allow replacement batteries to be secured.
- N. Battery charger output and performance shall be compatible with the batteries furnished, including the maintenance charge rate.
- O. Battery charger shall be adjusted for charging the specific lead-acid batteries provided, and shall be Alcad SLR Series; Exide SCR Series; or approved equal by C&D Charter Power Systems, Hindle,

LaMarche Manufacturing Company, Sens or engine-generator set manufacturer's standard offering.

2.10 ACCESSORIES

- A. Remote Manual Stop Station (Emergency Power Off – EPO): Provide two (2) red, mushroom head, maintained contact type emergency power off (EPO) push buttons in a NEMA Type 4X stainless steel or painted, cast aluminum control enclosure for emergency shutdown of the generator. on the outside of the generator set outdoor enclosure next to the generator control panel access door.
1. One (1) factory mounted on the outside of the engine-generator set outdoor enclosure with clear, UV resistance spring loaded hinged cover with provisions for padlocking.
 2. One (1) shipped loose for installation adjacent to the generator remote annunciator panel in the Visitors Center as indicated on the Drawings.
- B. EPO push buttons shall be of the same type and design as the EPO push button mounted in the Generator Control Panel.
- C. The engine-generator manufacturer shall provide automatic monitoring of the EPO switches. The remote EPO shall be field wired and the EPO mounted on the outside of the engine-generator set weatherproof enclosure shall be factory wired to the Generator Control Panel and the resistive load bank such that activation of any of the EPO push buttons, including the one on the Generator Control Panel, shall shut down the engine-generator immediately without a cool-down time period, shut down the resistive load bank, trip the generator main line output circuit breaker open, and initiate a visual and audible alarm at both the local and the remote generator annunciator panels.
- D. Provide an engraved laminated plastic nameplate on all generator EPO push button enclosures with engraved white characters on a red background with the following wording:

GENERATOR
E-STOP

- E. Fuel Oil Tank: Fuel oil tank shall be a factory packaged, fuel oil supply system suitable for outdoor use for emergency generators and mounted under the sound attenuated weatherproof diesel-engine-driven generator set enclosure. Fuel tank shall be designed and constructed in accordance with UL Standards 142 and 508 and NFPA 30, 37, and 110. Fuel tank and associated electronic control system shall be UL 142 and 508 listed. Fuel tank shall be provided with primary (inner) storage tank and secondary (outer) rupture basin sized for a minimum of 150% of primary tank capacity. Both primary and secondary tanks shall be of heavy gauge (minimum 12 gauge), welded steel construction. The primary tank shall have a diesel fuel capacity that is adequate for 24 hours of operation of the generator set at full rated load. Fuel tank shall include the following accessories, controls, and instrumentation.
1. Supply pump suction strainers/filters.
 2. Engine return fuel cooler if one is not mounted on the engine.
 3. Visual fuel level gauge.
 4. Critical Low Fuel Level Switch– Alarm – local/remote.
 5. Critical Low Low Fuel Level Switch – Engine Shutdown, Alarm – local/remote.
 6. Primary tank supply pump connection – minimum 1” NPT with dip tube.
 7. Primary tank reverse pump connection – minimum 1” NPT with dip tube.
 8. Primary tank engine supply connection – minimum 1” NPT with dip tube.
 9. Primary tank engine return connection – minimum 1” NPT with dip tube.

10. Primary tank overflow – minimum 1” NPT.
11. Primary tank normal vent – minimum 2” NPT.
12. Primary tank normal vent cap – minimum 2” NPT, mushroom type, galvanized carbon steel with screen.
13. Primary tank inspection port – minimum 6”.
14. Primary tank emergency vent connection – size per NFPA requirements.
15. 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.
16. Primary tank manual fill – 2” NPT with lockable cap.
17. Rupture basin drain – 1” NPT.
18. Rupture basin leak detector - Supply Pump Shutdown and alarm – local/remote.
19. Lift lugs.
20. Anchor lugs.
21. Rupture basin: primed and finished painted on interior and exterior.
22. Primary tank: epoxy coating on interior, primed and finish painted on exterior.

2.11 DIESEL-ENGINE-DRIVEN GENERATOR SET ENCLOSURE

- A. Provide a factory installed, sound attenuated, durable, weather protective enclosure to provide protection as specified by OSHA from all moving and hot parts of the engine, generator and radiator.
- B. The enclosure construction shall allow full access to the engine for maintenance without exposing personnel to any moving machinery.
- C. Radiator and fan assembly shall be totally enclosed with lockable door over the radiator cap. The radiator shall be sized to accommodate any resulting flow restrictions caused by the enclosure without further derating of the unit.
- D. Provision shall be made for a duct flange or perforated metal grill to protect the radiator core.
- E. Enclosure shall have removable doors with stainless steel hinges and removable end panels to allow easy access for routine maintenance. All doors and access panels shall have rubber gaskets and lockable stainless steel security latches and shall not have any burrs or sharp edges.
- F. Louvers shall allow sufficient airflow to allow full load operation of the generator set. The louvers shall be twisted to deflect water and direct noise downward.
- G. The enclosure shall be of drip-proof construction acceptable for exterior installations when doors and access panels are in place.
- H. The enclosure shall be fitted to the generator set base and isolated from engine vibration. Corners shall be formed and welded to assure strength and rigidity. The roof shall be sloped to prevent accumulation of moisture.
- I. Enclosure sheet metal shall be minimum 18 gauge cold rolled steel.
- J. Exposed fasteners shall be zinc plated or stainless steel.
- K. Enclosure shall be painted utilizing environmentally friendly, electrostatically applied polyester power baked paint. Color shall be white, beige or manufacturer’s standard color subject to approval by the Owner.

- L. The exhaust silencing system shall be housed within the enclosure for personnel safety and to maximize the life of the silencer.
- M. The enclosure shall be designed and insulated as required to provide for a maximum full load sound level of 68.6 dBA at 23 feet from the enclosure.
- N. Lube oil, coolant and fumes disposal lines shall be terminated on the base of the frame for easy access.
- O. A radiator sight gauge shall be provided for easy visual verification of coolant level.
- P. Provide fire extinguisher(s) mounted within the enclosure if/as required by NFPA 37 requirements.

2.12 MISCELLANEOUS

- A. All moving parts shall have metal guards to prevent entanglement of falling objects and provide personnel protection.
- B. The complete diesel-engine-driven generator unit shall be given a finishing coat of the manufacturer's standard heat-resisting enamel.
- C. Furnish one (1) quart or two (2) 16 oz aerosol spray cans of touch-up paint of the color used on the factory provided weatherproof enclosure.
- D. In addition to all items specified above, the following items shall be included and installed:
 - 1. Lubrication oil
 - 2. One oil sampling kit for the engine shall be provided, with instructions for proper use, in order to forecast and minimize engine downtime.
 - 3. One lot of spare filters for the diesel-engine-driven generator as recommended by the manufacturer.

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 diesel-engine-driven generator manufacturer's written instructions and as indicated on the Drawings.
- C. Provide conduit and wiring/cabling in accordance with the diesel-engine-driven 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. Battery(ies) shall not be installed until the battery charger is in service.
- E. Install remote annunciator in location shown on the Drawings. Provide control wiring from generator control panel to remote annunciator in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams.
- F. Remove rust from all scratches on diesel-engine-driven generator set enclosure and doors and touch-up the paint finish using manufacturer provided touch-up paint in an aerosol spray can.

3.3 ARC FLASH HAZARD WARNING LABELS

- A. Provide an arc flash hazard warning label on front exterior of the enclosure of the main line circuit breaker and the load bank circuit breaker mounted on the generator in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

3.4 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. The diesel-engine-driven generator supplier 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, fuel tank, 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. The Contractor shall verify proper voltage and phase rotation at the automatic transfer switch before connecting to the load
- C. The diesel-engine-driven generator set shall be furnished from the factory with the proper mix of engine coolant installed or the 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. All coolant shall be thoroughly mixed BEFORE placing into the cooling system radiator at the factory or job site when the radiator ships loose. Coolant shall be placed into the cooling system through the fill cap opening of the radiator.
- D. Prior to any testing, and before starting the diesel engine, the diesel-engine-driven generator manufacturer's authorized service representative shall perform the following:
 - 1. Fuel, lubricating oil, and coolant 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 electrically loading of the generator set, the controls shall be tested for normal operation.
- E. Provide portable resistive load test bank for full load test if full load cannot be supplied by a combination of the connected facility load and the permanently installed resistive load bank. Simulate power failure including operation of automatic transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.
- F. The Contractor shall fill the fuel tank prior to start of test. The Designer and the Construction Representative 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:
 1. With the prime mover in a “cold start” condition and the building and cave load at standard operating level, a primary power failure shall be initiated by opening the main 400A service entrance disconnect switch next to the pad-mount utility transformer near the generator set.
 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 restored, the time delay on retransfer to primary for the ATS, 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 4-hour, full load test shall be performed using the permanently installed resistive load bank and the connected facility load. Provide a supplemental portable resistive load bank, if necessary, 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.
 14. 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.
 15. 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. Oil pressure
 - g. Engine exhaust temperature
 - h. Engine inlet temperature
 - i. Oil Temperature
 - j. Battery charge rate

16. 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.
 17. Test alarm and shutdown circuits as typically performed by the generator supplier.
 18. Correct all malfunctions such as the elimination of all oil and water leaks, miss-wiring and improper control functions found during testing.
- H. The diesel-engine-driven generator manufacturer's authorized service representative shall provide all of the 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 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 the Construction Representative.
- J. Contractor shall fill fuel tank upon completion of test.
- K. 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.

3.5 ADJUSTING

- A. Adjust generator output voltage and engine speed.

3.6 CLEANING

- A. Clean work under provisions of Division 0 and Section 017400 - Cleaning.
- B. Clean engine and generator surfaces.

3.7 DEMONSTRATION

- A. Provide systems demonstration. Coordinate the demonstration schedule with the Construction Representative and the Designer.
- B. Describe loads connected to emergency and standby systems and restrictions for future load additions.
- C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

3.8 TRAINING

- A. Provide two (2) hours of on-site training by factory trained field service technician 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. This shall be done after completion of the acceptance testing. Training session shall be video recorded by the

diesel-engine-driven generator supplier and two (2) copies of the video on DVD shall be provided to the Construction Representative.

END OF SECTION 263213.13

SECTION 263236 – RESISTIVE LOAD BANKS

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 specification contains the minimum requirements for the design, manufacture and testing of a UL listed, air-cooled, outdoor weatherproof resistive load bank or engine-generator set radiator mounted, outdoor weatherproof resistive load bank with locally mounted automatic control panel.
- B. The load bank is required for periodic exercising and testing of the standby emergency power source. The load bank shall be permanently mounted in a weatherproof enclosure, forced air cooled or shall use the air discharge from the generator radiator for cooling.
- C. Either a stand-alone vertical airflow load bank, field installed by the Contractor, or a radiator mounted load bank, installed by the diesel engine-generator set packager, are acceptable in accordance with the requirements herein.

1.3 RELATED SECTIONS

- A. Division 3 – Concrete
- B. Section 260500 – Common Work Results for Electrical
- C. Section 260526 – Grounding and Bonding for Electrical Systems
- D. Section 260529 – Hangers and Support for Electrical Systems
- E. Section 260553 – Identification for Electrical Systems
- F. Section 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment
- G. Section 260583 – Wiring Connections
- H. Section 262813 – Fuses
- I. Section 263213.13 – Diesel-Engine-Driven Generator Set

1.4 SUBMITTALS

- A. The manufacturer shall submit for review technical data including features, performance, electrical characteristics, physical characteristics, ratings, accessories, and finishes.
- B. Shop drawings shall include dimensional plans, front and side elevations and mounting details sufficient to properly install the load bank. Load bus configuration and load connections termination area shall be clearly identified.

- C. Electrical schematic drawings shall be provided to detail the operation of the load bank and the provided safety circuits. Over-current protection and control devices shall be identified and their ratings marked. A system interconnection drawing shall be included for control wiring related to the load bank.
- D. Provide recommended spare parts list, including pricing.

1.5 STANDARDS

- A. The equipment covered by this specification shall be designed with the latest applicable NEMA, NEC, IEEE and ANSI standards.
- B. The load bank shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) to UL Standard 508A.

1.6 WARRANTY

- A. A full two (2) year warranty shall be provided for both the resistors and the load bank.

PART 2 - PRODUCTS

2.1 RATINGS

- A. The total capacity of the load bank shall be rated 25 kW at 240 Volts, 1-Phase, 3-Wire, 60 Hertz, 100 Amps per Phase at unity Power Factor and 5 kW minimum load step resolution.
- B. The load bank shall be designed for continuous duty cycle operation with no limitations. The load bank shall operate in an ambient temperature of -28°C to 49°C (-20°F to 120°F).

2.2 MATERIAL AND CONSTRUCTION

- A. The load bank shall either be designed for installation on the radiator end of the engine-generator set outdoor enclosure by the generator set packager or shall be of outdoor weatherproof construction, suitable for installation on a concrete pad by the installation contractor. All exterior fasteners shall be stainless steel. Separately mounted load bank shall include forklift channels in the base for lifting.
- B. The load bank shall be constructed of heavy gauge aluminized steel per ASTM A463. Aluminized steel provides superior corrosion protection and extended service life, with a better tolerance to high heat exposure compared to the more common galvanized steel.
- C. The main input load bus, load step relays, fuses, control relays and blower (for separately mounted unit) shall be located within the load bank enclosure. A thermostatically controlled 120VAC, 1-phase heater shall be located within the control section to provide protection to the control devices from the effects of moisture and condensation.
- D. Airflow throughout the separately mounted load bank shall be vertical. Ambient intake cooling air shall be drawn in at the base of the unit and heated air exhausted out the top. Intake openings shall be designed to prevent objects greater than 0.50" diameter from entering the unit.
- E. The load bank exhaust hood on the separately mounted unit shall be angled and include interior baffle plates to direct falling rain from the interior of the load bank. The exhaust hood shall be constructed of non-corrosive aluminized steel or aluminum.

- F. The size and configuration of the radiator mounted load bank shall be coordinated with the engine-generator set manufacturer for compatibility.
- G. The load bank enclosure shall have a baked polyester powder coated finish with a film thickness of 2.8 +/- 0.4 Mil per coat. Color of radiator mounted unit shall be the same as that of the engine-generator set weatherproof enclosure.
- H. Load elements shall be contained in an integral resistor case allowing resistors to be individually removed for inspection or service.
- I. The load bank shall be of riveted construction to provide a stronger framework.
- J. Remote controlled contactors shall be provided to switch groups of load elements. Contactor coils shall be rated 120VAC, 1-phase. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within the load bank enclosure and shall be accessible from the exterior of the load bank through bolt-on panels with stainless steel hardware.
- K. The load bank assembly shall be UL 508A listed and labeled and shall include an externally mounted equipment label containing all information required by UL 508A, including the short circuit current rating (SCCR).

2.3 RESISTIVE LOAD ELEMENTS

- A. Load elements shall be Avtron Helidyne™, helically wound chromium alloy rated to operate at approximately ½ of maximum continuous rating of wire. Elements must be fully supported across the entire length within the air stream by segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short circuit to adjacent elements or to ground.
- B. The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.
- C. The overall tolerance of the load bank shall be -0% to +5% kW at rated voltage. A -5%, +5% rating allows the load bank to deliver less than rated kW and shall not be used. The load bank must deliver full rated kW at rated voltage.
- D. The resistors shall not require a cooldown period. An emergency shut down of the engine-generator set or failure shutdown of the cooling fan (for separately mounted load bank) during operation of the resistors shall not shorten their life expectancy.
- E. Sealed wire type elements, which have the internal resistance wire totally enclosed, prevent internal cooling of the element wire and shall not be used.

2.4 COOLING

- A. Radiator Mounted Load Bank: The load bank shall be designed to obtain adequate cooling from the radiator fan on the engine-generator set. The load bank shall have a static pressure drop of approximately 0.1" H₂O at design velocity (50 ft/min).
- B. Separately Mounted Load Bank: The load bank shall be cooled by an integral TEFC or TEAO motor which is direct coupled to the cooling fan blade. The fan motor must be electrically protected against overload using a motor overload device and short circuit protected using two (2) current limiting fuses with an interrupting rating of 200kAIC. The fan blade shall be an airfoil design constructed from aluminum or other non-corroding material.

2.5 PROTECTIVE DEVICES

- A. A differential pressure switch shall be provided on separately mounted load bank to detect air loss. The switch shall be electrically interlocked with the load application controls to prevent load from being applied if cooling air is not present.
- B. An over-temperature switch shall be provided to sense the load bank exhaust in the resistor case assembly. The switch shall be electrically interlocked with the load application controls to remove load from being applied in the event of an over temperature condition.
- C. To provide for major fault protection, branch fuses shall be provided on all both phases of all load steps. Branch fuses shall be current limiting type with an interrupting rating of 200kAIC.
- D. The fan motor on separately mounted load bank shall be separately protected by motor overload and short circuit current devices.
- E. The load bank shall have a UL listed and labeled short circuit current rating of 10kA RMS symmetrical.
- F. The resistive load bank shall not be ordered until the required short-circuit current rating for the load bank has been verified in accordance with Section 260573 - Overcurrent Protective Device Coordination and Arc Flash Risk Assessment.
- G. The exterior of the load bank shall have appropriate warning/caution statements on access panels.

2.6 CONTROL PANEL

- A. The control panel shall be 19" rack mounted panel housed in a NEMA 4 type enclosure mounted on the load bank. The control panel shall contain the following manual controls:
 - 1. Power ON/OFF switch
 - 2. Blower START/STOP push buttons (separately mounted load bank only)
 - 3. Master load ON/OFF switch
 - 4. Load step switches for ON/OFF application of individual load steps
 - 5. AUTO/MANUAL selector switch
- B. Control panel visual indicators shall be as follows:
 - 1. Control power ON indication light
 - 2. Blower power ON indication light (separately mounted load bank only)
 - 3. Blower/Air FAILURE indication light (separately mounted load bank only)
 - 4. OVERTEMPERATURE indication light
 - 5. AUTO indication light
- C. A standard remote load dump circuit shall be provided as part of the load bank control circuit. Provisions shall be provided to remove the load bank off-line from the operation of a remote normally closed set of auxiliary contacts from a transfer switch or other device. In the event of the remote contact opening, all load is removed.
- D. An Automatic Load Controller shall be provided for maintaining a minimum load on the generator set. The controller shall monitor the connected downstream loads and will automatically add or subtract load steps in response to building load changes as to maintain a minimum load level on the generator set. The controller shall include an initial time-delay circuit and automatic time

delayed load step application circuit. A remote contact closure shall be required for activation and transfer of control. A separate current transformer shall be supplied loose for mounting and sensing of downstream loads. The current transformer shall have a ratio of 200:5A and shall be sized as required to fit around the Phase A or Phase B load side conductor inside the generator output circuit breaker enclosure on the generator or the Phase A or Phase B emergency source conductor inside the 400A ATS.

- E. A digital meter shall be installed in the load bank control panel to show a 3-line extra-bright LED digital display of voltage, current, frequency and power measurements. The meter shall include a software interface to allow for real-time data acquisition and data logging from a laptop PC.

2.7 DOCUMENTATION

- A. Installation and operation manuals shall be provided with the equipment and shall include complete details for the installation, commissioning, operation, troubleshooting, and maintenance of the load bank.
- B. The manuals shall include the electrical schematic and interconnect drawings for the power and control wiring for the load bank and all control devices.
- C. A complete parts list with part numbers, device identification, and ratings shall be included in the manuals. The original manufacturers name and part number shall be included in the parts listing.
- D. Three (3) sets of manuals shall be provided with the load bank or the manuals can be provided electronically on a USB drive.

2.8 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with all requirements specified herein, provide products by one of the following:
 - 1. ASCO Power Technologies, Avtron Load Bank Products
6255 Halle Drive
Cleveland, Ohio 44125
Phone: 216-573-7600
Email: customercare@ascopower.com | Website: www.loadbanks.ascopower.com
 - 2. Loadtec Load Technology, Inc.
525 Commerce Circle
Mesquite, NV 89027-1900
Phone: 800-562-3832
Email: sales@loadtec.com | Website: www.loadtec.com
 - 3. Simplex, Inc.
5300 Moon Road
Springfield, Illinois 62711-6228
Phone: 800-637-8603
Email: johnh@simplexdirect.com | Website: www.simplexdirect.com
- B. The design of the resistive load bank installation has been based on an ASCO Model 4100 (pad-mount) or Model 1100 (radiator-mount) load bank. Should the Contractor choose to provide equipment from one of the approved equal manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories.

2.9 QUALITY CONTROL

- A. The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value. The load bank manufacturer shall maintain this test data on file for inspection by the purchaser.
- B. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame. Tests of all safety circuits shall be performed to verify conformance to the specification.
- C. All electrical circuits shall have a high potential insulation resistance test performed at twice rated voltage plus 1000 VAC to assure insulation integrity.
- D. All quality control test equipment shall be regularly maintained and calibrated to traceable national standards.
- E. The load bank manufacturer's quality control system shall be ISO9001:2015 Certified.

2.10 QUALIFICATIONS OF MANUFACTURER

- A. The load bank shall be manufactured by a firm regularly engaged in the manufacture of load banks and who can demonstrate at least twenty-five (25) years' experience with at least twenty-five (25) installations of load banks similar or equal to the ones specified herein.
- B. The manufacturer shall have a written Quality Control procedure available for review by the purchaser, which will document all phases of operations, engineering, and manufacturing.
- C. Manufacturer must have a field service organization with service personnel having a minimum of an Associate Degree in Electrical Engineering.
- D. The manufacturer shall have a service organization capable of providing service for the load bank within a 24-hour time frame from initial contact.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's written instructions.
- B. All power and control conduits shall enter/exit the bottom of the equipment enclosure at the location indicated on the equipment drawing.
- C. Provide reinforced concrete pad for installation of the pad-mount type load bank as indicated on the Project Drawings.
- D. Set equipment on pad in its final location. Do not slide equipment on concrete pad to avoid damaging the factory corrosion protection finish on the bottom of the unit.
- E. Engine-generator set radiator mounted, outdoor weatherproof resistive load bank shall be shipped to the diesel-engine-driven generator manufacturer's facility to be factory installed prior to shipment to the project site.

- F. Connect power and control cables to load bank and automatic control panel as indicated on the equipment drawings and torque all terminations in accordance with the equipment manufacturer's recommendations.
- G. Touch up all blemishes in factor finish on the equipment using the method recommended by the equipment manufacturer and using touch-up paint provided by the equipment manufacturer.

3.2 ARC FLASH HAZARD WARNING LABELS

- A. Provide an arc flash hazard warning label on front exterior of the enclosure of the resistive load bank in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

3.3 STARTUP AND COMMISSIONING

- A. Provide startup and commissioning of the equipment by a factory authorized and factory trained field startup technician.
- B. Test functional operation of the load bank in both automatic and manual modes of operation from minimum to full rated load of the load bank.
- C. Repair and retest until equipment is fully functional as designed.
- D. Provide field startup report for Owner's records indicating the date and time and name of the technician who performed the equipment startup and commissioning services.

3.4 DEMONSTRATION AND OWNER TRAINING

- A. Factory authorized and trained field service technician shall instruct the Owner's maintenance personnel on the operation of the load bank in both manual and automatic modes and on preventative maintenance and serving of all Owner serviceable components.

END OF SECTION 263236

SECTION 263613 – NON-AUTOMATIC TRANSFER 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 a non-automatic transfer switch (NTS) as specified herein and as shown on the Drawings. The NTS shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide a complete non-automatic transfer operation.
- B. The non-automatic transfer switch shall be used to manually transfer the Onondaga Cave State Park emergency power source from the permanently installed diesel-engine-drive generator set, specified in Section 263213.13 – Diesel-Engine-Driven Generator Set, to a temporary mobile emergency generator.

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 Support for Electrical Systems
- 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 263213.13 – Diesel-Engine-Driven Generator Set

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for non-automatic transfer switch including, but not limited to, service voltages, number of phases, frequency, continuous current ratings, withstand current ratings and enclosure type. Product data sheets shall indicate all standard features, special features and optional features that are to be provided. Provide data on microprocessor based NTS controller including programming options.
- B. Shop Drawings: Submit dimensioned plan view and elevation view outline drawings and internal physical diagrams for the NTS.
- C. Wiring Diagrams: Submit wiring diagrams for the NTS showing internal and external connections for power, control, and communications wiring.
- D. NTS submittals will not be approved until the short-circuit current report specified in Section 260573 – Overcurrent Protective Device Coordination and Arc Flash Risk Assessment has been submitted for review.

- E. Submit operation and maintenance (O&M) data under the provisions of Section 260500 – Common Work Results for Electrical.
- F. O&M Manuals shall be conformed to “as-built” status by incorporating all changes made during the startup period.

1.5 REFERENCES

- A. The non-automatic transfer switch shall be designed and manufactured according to the applicable provisions of the latest revision of the following codes and standards:
 - 1. NFPA 70 – National Electrical Code, including use in emergency and standby systems in accordance with Articles 700, 701 and 702
 - 2. NFPA 101 – Life Safety Code
 - 3. NFPA 110 – Standard for Emergency and Standby Power Systems
 - 4. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
 - 5. IEEE Standard 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
 - 6. IEEE Standard 472 (ANSI C37.90A) – Ringing Wave Immunity
 - 7. NEMA Standard ICS10 – AC Automatic Transfer Switches
 - 8. UL 50 – Enclosures for Electrical Equipment
 - 9. UL 508 – Industrial Control Equipment
 - 10. UL 1008 – Standard for Transfer Switch Equipment
 - 11. IEC 60947-6-1 Multiple Function Equipment Transfer Switching Equipment
 - 12. EN55022 Class B – (CISPR11): Conducted and Radiated Emissions
 - 13. EN61000-4-2 (Level 4) – Electrostatic Discharge (ESD) Immunity Test
 - 14. EN61000-4-3 (ENV50140) – Radiated Electromagnetic Field Immunity Test
 - 15. EN61000-4-4 – Electrical Fast Transient (EFT)/Burst Immunity Test
 - 16. EN61000-4-5 (IEEE C62.41) – Surge Transient Immunity Test
 - 17. EN61000-4-6 (ENV50141) – Conducted Radio-Frequency (RF) Field Immunity Test
 - 18. EN61000-4-11 – Voltage Dips and Interruption Immunity

1.6 QUALIFICATIONS

- A. The manufacturer of the NTS assembly shall have produced similar electrical equipment for a minimum of twenty-five (25) years. When requested by the Designer, an acceptable list of a minimum of ten (10) installations with similar equipment shall be provided to demonstrate compliance with this requirement.
- B. The NTS manufacturer shall maintain a full parts and service center with 24/7/365 service availability within one hundred (100) miles of the project site and all service personnel shall be factory trained.
- C. The NTS and control panel shall be the product of the same manufacturer.
- D. As a precondition for approval, the non-automatic transfer switch, complete with accessories, shall be listed by Underwriters Laboratories, under Standard UL 1008 (transfer switches) and approved for use on emergency systems. The NTS assembly shall be labeled by a Nationally Recognized Testing Laboratory (NRTL).

- E. Provide equipment that is IBC/CBC seismically qualified with seismic freestanding or wall mount label. Refer to Section 263213.13 – Diesel-Engine-Driven Generator Set for earthquake design data for the project site.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Inspect equipment and report concealed damage to carrier within their required time period.
- B. Handle equipment carefully and in accordance with manufacturer’s recommendations to avoid damage to internal components, enclosure, and finish.
- C. Store equipment in a clean, dry indoor environment. Maintain factory packaging until time of installation. Cover with heavy canvas or plastic to keep out dirt, water, and construction debris. Heat enclosures to prevent condensation.

1.8 WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a minimum period of one (1) year from date of substantial completion of the project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The NTS shall be used to non-automatically transfer the assigned load (L) from the "Normal" (N) source (permanently installed emergency generator set) to the "Emergency" (E) source (temporary mobile emergency generator unit) upon a loss of the “normal” power source and to non-automatically retransfer from the “emergency” source back to the “normal” source upon restoration of the “normal” power source. The NTS shall be used to transfer the load in both directions in “open transition” mode (break before make).
- B. The NTS unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices are not acceptable. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal and emergency.
- C. The NTS shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. A neutral terminal plate with fully rated AL-CU pressure connectors shall be provided for solid connection of the utility, emergency and load neutral conductors.
- G. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

- H. Inspection of all contacts (movable and stationary) shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors, to facilitate inspection and maintenance.
- I. A manual handle shall be provided for maintenance purposes with the switch de-energized. The handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.
- J. A means shall be provided to manually operate the transfer switch in the event of switch failure.

2.2 RATING

- A. The NTS shall be rated for 100% continuous duty for all classes of inductive and non-inductive loads. The transfer switch shall be rated for 240 volts, 1-phase, 60 hertz, 2 pole, 3 wire. The ampere rating of the switch shall be as indicated on the Drawings.
- B. The NTS shall have 600-volt insulation on all parts in accordance with NEMA standards.
- C. The current rating shall be a 24-hour continuous rating when the switch is installed in an unventilated enclosure and shall conform to NEMA temperature rise standards.
- D. The thermal capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of 3 electrical cycles as established by certified test data.
- E. The minimum UL listed Withstand and Closing Ratings shall be 22,000 RMS symmetrical amperes at 240 volts, 60 Hz for 3 cycles. Before ordering the NTS, the SE rated enclosed main circuit breaker or the diesel engine-generator set, verify with NTS manufacturer that the SE rated enclosed main circuit breaker specified in Section 262816.13 – Enclosed Circuit Breakers and the generator output circuit breaker provided with the diesel-engine-driven generator set specified in Section 263213.13 – Diesel-Engine-Driven Generator Set will provide the required 22 kA RMS symmetrical withstand and closing rating for the NTS.
- F. The NTS shall be "fully rated." A "series rated" switch is not acceptable.

2.3 MICROPROCESSOR BASED CONTROLLER

- A. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via an Ethernet connection through an optional communications module.
- B. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to ± 0.1 Hz. Time delay settings shall be accurate to $\pm 0.5\%$ of the full-scale value of the time delay. The panel shall be capable of operating over a temperature range of -20°C to 70°C and a storage temperature from -55°C to 85°C .
- C. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

- D. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment
 - a. IEC 61000-4 Testing and Measurement Techniques - Overview
 - b. IEC 61000-4-2 Electrostatic Discharge Immunity
 - c. IEC 61000-4-3 Radiated RF Field Immunity
 - d. IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
 - e. IEC 61000-4-5 Surge Immunity
 - f. IEC 61000-4-6 Conducted RF Immunity
 - 2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions
- F. Controller Operator Provisions
 - 1. The controller shall be arranged for manually actuated electrical operation with provisions for remote operation using 18 AWG wire minimum.
 - 2. The NTS shall also be configured so that it can easily be capable of automatic operation in the future without modification.+
- G. Controller Display and Keypad
 - 1. A backlit 128*64 graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.
 - a. Nominal line voltage and frequency
 - b. Single or three phase sensing on normal
 - c. Transfer operating mode configuration, (open transition, or delayed transition)
 - 2. All instructions and controller settings shall be easily accessible, readable, and accomplished without the use of codes, calculations, or instruction manuals.
 - 3. The 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

2.4 VOLTAGE AND FREQUENCY SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified).

<u>Parameter</u>	<u>Sources</u>	<u>Dropout/Trip</u>	<u>Pickup/Reset</u>
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to 116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%
Overfrequency	N & E	101 to 111%	2% below trip

- B. Repetitive accuracy of all settings shall be within 1% at 25°C.
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- D. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage and frequency. Single-phase sensing on the emergency source shall be provided.

2.5 TIME DELAYS

- A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface. Initial setting for this time delay shall be 2 second.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface. Initial setting for this time delay shall be 1 seconds.
- C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds. Initial setting for this time delay shall be 1 second.
- D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable. Initial setting for this time delay shall be 10 minutes.
- E. A cooldown time delay shall be provided on shutdown of engine generator, Adjustable 0 to 60 minutes 59 seconds. Initial setting for this time delay shall be 0 if engine cooldown timer is included in the generator control panel. Otherwise, the initial setting for this time delay shall be 5 minutes.
- F. All adjustable time delays shall be field adjustable without the use of special tools.
- G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:
 - 1. Prior to transfer only
 - 2. Prior to and after transfer
 - 3. Normal to emergency only
 - 4. Emergency to normal only
 - 5. Normal to emergency and emergency to normal
 - 6. All transfer conditions or only when both sources are available
- H. If the alternate source is not accepted within the configured Failure to Accept time delay, the common alert indication shall become active.
- I. The controller shall also include the following built-in time delay for delayed transition operation:
 - 1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds.

2.6 ENCLOSURE

- A. The NTS shall be furnished in a NEMA Type 3R steel hinged door enclosure with ANSI 49 or ANSI 61 light gray paint finish.
- B. Alternate Bid No. 1: Provide NEMA Type 4X, Type 304 stainless steel hinged door enclosure in lieu of the NEMA Type 3R enclosure.
- C. Enclosure shall be dead front type with outer door to conceal and protect the microprocessor-based controller unit from tampering and from the weather.
- D. Provide 125 watt thermostatically controlled (adjustable from 30°F to 140°F) strip heater wired to a 15A/1P branch circuit breaker in Panelboard MDP with required overcurrent protection inside the NTS enclosure to prevent condensation from forming. Set thermostat to 90°F.

2.7 ADDITIONAL FEATURES

- A. The non-automatic transfer switch shall include the following items as a minimum.
 - 1. Voltage sensitive relays for full voltage protection.
 - 2. The user interface shall be provided with the following soft keys:
 - a. To transfer between the normal and emergency sources.
 - b. To simulate a normal source failure.
 - c. To bypass the time delay on transfer to the emergency source.
 - d. A lamp test for testing all indicator lights simultaneously.
 - 3. A set of contacts rated 30VDC, 5A, for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cooldown setting, regardless of whether the normal source restores before the load is transferred.
 - 4. Two (2) auxiliary contacts, rated 10A, 250VAC, shall be provided consisting of one contact that is closed when the NTS is connected to the normal source and one contact that is closed when the NTS is connected to the emergency source.
 - 5. A single alarm indication shall light up the alert indicator and de-energize the configured common alarm output relay for external monitoring.
 - 6. LED indicating lights shall be provided to indicate the following:
 - a. Green to indicate switch is in NORMAL power position
 - b. Red to indicate switch is in the EMERGENCY power position
 - c. Green to indicate NORMAL power source is available
 - d. Red to indicate EMERGENCY power source is available
 - e. Amber to indicate NOT IN AUTO condition, and
 - f. Blinking amber to indicate transfer inhibit
 - g. Red to indicate any alarm condition or active time delay
 - 7. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.
 - 8. LED indicating light shall be provided to indicate switch is not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.
 - 9. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).

10. Terminals shall be provided for a remote contact which opens to signal the NTS to transfer to the emergency source and for remote contacts to inhibit transfer to emergency. This inhibit signal shall be enabled through the user interface keypad.
11. Variable window in-phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources. The in-phase monitor shall be specifically designed for and be the product of the NTS manufacturer.
12. System Status Display: The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key. This screen shall display a clear description of the active operating sequences and switch position. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be interpreted by referring to the Operator's Manual, are not acceptable.
13. Self-Diagnostics: The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
14. Communications Interface: The controller shall be capable of interfacing, through an optional serial communication port with a network of transfer switches, locally (up to 4,000 feet). Standard software specific for transfer switch applications shall be available from the NTS manufacturer. This software shall allow for the monitoring, control, and setup of parameters. The optional communications is not required to be provided.
15. Data Logging: The controller shall have the ability to log data and to maintain the last 300 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in non-volatile memory.
 - a. Event Logging
 - i. Date, time, and reason for transfer from normal to emergency
 - ii. Date, time, and reason for transfer from emergency to normal
 - iii. Date, time, and reason for engine start
 - iv. Date, time, and reason engine stopped
 - v. Date and time emergency source available
 - vi. Date and time emergency source not available
 - b. Statistical Data
 - i. Total number of transfers
 - ii. Total number of transfers due to source failure
 - iii. Total number of days controller is energized
 - iv. Total number of hours both normal and emergency sources are available
 - v. Total time load is connected to normal
 - vi. Total time load is connected to emergency
 - vii. Last engine start
 - viii. Last engine run time
 - ix. Input and output status
16. An engine generator exercising timer shall be provided to configure weekly or bi-weekly automatic testing of an engine generator set with or without load for a fixed time of 20 minutes. It shall be capable of being configured to indicate the day of the week, and the time weekly testing should occur.
17. Provide aluminum receptacle housing mounted on the left side of the NTS enclosure with 16 Series Camlock male connectors wired to the emergency side of the transfer switch for

connection to an alternate source. Connector configuration shall be 120/240V, 2-pole, 230A to 400A.

2.8 NAMEPLATES

- A. All devices mounted on the transfer switch enclosure door, as well as individual items mounted inside the enclosure, shall be provided with a nameplate to show the identification and/or function of the device or item.
- B. All nameplates shall be engraved laminated plastic in accordance with Section 260553 - Identification for Electrical Systems. Unless otherwise indicated, all nameplates shall have 1/4-inch high characters.
- C. Provide a permanent factory equipment nameplate/label that provides pertinent information about the NTS including manufacturer, model number, order number, serial number, voltage, amperage, frequency, number of phases or switched poles, etc.

2.9 APPROVED MANUFACTURERS

- A. Subject to compliance with all requirements specified herein, provide products by one of the following:
 - 1. ASCO
 - 2. ABB-GE-Zenith
 - 3. Russelectric
- B. The design of the non-automatic transfer switch installation has been based on an ASCO Series 300 (Type 3NTS) non-automatic transfer switch. Should the Contractor choose to provide equipment from one of the approved equal manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories.

PART 3 - EXECUTION

3.1 FACTORY TESTS AND CERTIFICATION

- A. The non-automatic transfer switch, complete with the controller and all accessories, shall be listed by Underwriters' Laboratories, Inc. (UL), and shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements. The factory testing shall include a dielectric strength test per NEMA Standard ICS1-109.21.
- B. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The NTS manufacturer shall submit test data for each switch, verifying that the switch can withstand, without damage, fault currents of the magnitude and the duration necessary to maintain the system integrity.

3.2 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's written instructions.
- B. Mount equipment on stainless steel U-channel support rack, using stainless steel fasteners as indicated on the Drawings.
- C. All power and control conduits shall enter/exit the bottom, sides or back of the equipment enclosure at the locations indicated on the equipment drawing. There shall be no penetrations in the top of the enclosure.
- D. All conduit connections to the equipment shall be made using an insulated, grounding type threaded conduit hub in accordance with Specification Section 260533.13 – Conduit for Electrical Systems.
- E. Connect power conductors and control cables to equipment as indicated on the equipment drawings and torque all terminations in accordance with the equipment manufacturers recommendations.
- F. Remove rust from all scratches on NTS enclosure and door and touch-up the paint finish using manufacturer provided touch-up paint in an aerosol spray can.

3.3 ARC FLASH HAZARD WARNING LABELS

- A. Provide an arc flash hazard warning label on front exterior of the enclosure of the NTS in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

3.4 STARTUP AND COMMISSIONING

- A. Provide startup and commissioning of the equipment by a factory authorized and factory trained field startup technician.
- B. Adjust voltage and frequency settings as required for optimal operation and adjust timing relays as required to ensure the generator starts and the load is transferred to the generator within a maximum of 10 seconds from loss of normal utility power as required by NFPA 110.
- C. All LED indicators on the controller shall be tested for correct operation and sequence.
- D. Test functional operation of the non-automatic transfer switch in all modes of operation.
- E. Repair and retest until equipment is fully functional as designed.
- F. All testing shall be performed in the presence of and approved by the Construction Representative.
- G. Provide field startup report for Owner's records indicating the date and time and name of the technician who performed the equipment startup and commissioning services.

3.5 OWNER TRAINING

- A. A factory authorized and trained field service technician shall instruct the Owner's maintenance personnel on the proper operation of the non-automatic transfer switch and on preventative maintenance and serving of all Owner serviceable components.

END OF SECTION 263613

SECTION 263623 – AUTOMATIC TRANSFER 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 an automatic transfer switch (ATS) as specified herein and as shown on the Drawings. The ATS shall consist of a mechanically held power transfer switch unit and a microprocessor controller, interconnected to provide a complete automatic transfer operation.
- B. The automatic transfer switch shall be used to automatically transfer the Visitors Center and Onondaga Cave electrical loads from the normal (utility) power source to the new emergency generator specified in Section 263213.13 – Diesel-Engine-Driven Generator Set upon a failure of the normal power source.

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 Support for Electrical Systems
- 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 263213.13 – Diesel-Engine-Driven Generator Set

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for automatic transfer switch including, but not limited to, service voltages, number of phases, frequency, continuous current ratings, withstand current ratings and enclosure type. Product data sheets shall indicate all standard features, special features and optional features that are to be provided. Provide data on microprocessor based ATS controller including programming options.
- B. Shop Drawings: Submit dimensioned plan view and elevation view outline drawings and internal physical diagrams for the ATS.
- C. Wiring Diagrams: Submit wiring diagrams for the ATS showing internal and external connections for power, control, and communications wiring.
- D. ATS submittals will not be approved until the short-circuit current report specified in Section 260573 – Overcurrent Protective Device Coordination and Arc Flash Risk Assessment has been submitted for review.

- E. Submit operation and maintenance (O&M) data under the provisions of Section 260500 – Common Work Results for Electrical.
- F. O&M Manuals shall be conformed to “as-built” status by incorporating all changes made during the startup period.

1.5 REFERENCES

- A. The automatic transfer switch shall be designed and manufactured according to the applicable provisions of the latest revision of the following codes and standards:
 1. NFPA 70 – National Electrical Code, including use in emergency and standby systems in accordance with Articles 700, 701 and 702
 2. NFPA 101 – Life Safety Code
 3. NFPA 110 – Standard for Emergency and Standby Power Systems
 4. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
 5. IEEE Standard 241 – IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
 6. IEEE Standard 472 (ANSI C37.90A) – Ringing Wave Immunity
 7. NEMA Standard ICS10 – AC Automatic Transfer Switches
 8. UL 50 – Enclosures for Electrical Equipment
 9. UL 508 – Industrial Control Equipment
 10. UL 1008 – Standard for Transfer Switch Equipment
 11. IEC 60947-6-1 Multiple Function Equipment Transfer Switching Equipment
 12. EN55022 Class B – (CISPR11): Conducted and Radiated Emissions
 13. EN61000-4-2 (Level 4) – Electrostatic Discharge (ESD) Immunity Test
 14. EN61000-4-3 (ENV50140) – Radiated Electromagnetic Field Immunity Test
 15. EN61000-4-4 – Electrical Fast Transient (EFT)/Burst Immunity Test
 16. EN61000-4-5 (IEEE C62.41) – Surge Transient Immunity Test
 17. EN61000-4-6 (ENV50141) – Conducted Radio-Frequency (RF) Field Immunity Test
 18. EN61000-4-11 – Voltage Dips and Interruption Immunity

1.6 QUALIFICATIONS

- A. The manufacturer of the ATS assembly shall have produced similar electrical equipment for a minimum of twenty-five (25) years. When requested by the Designer, an acceptable list of a minimum of ten (10) installations with similar equipment shall be provided to demonstrate compliance with this requirement.
- B. The ATS manufacturer shall maintain a full parts and service center with 24/7/365 service availability within one hundred (100) miles of the project site and all service personnel shall be factory trained.
- C. The ATS and control panel shall be the product of the same manufacturer.
- D. As a precondition for approval, the automatic transfer switch, complete with accessories, shall be listed by Underwriters Laboratories, under Standard UL 1008 (automatic transfer switches) and approved for use on emergency systems. The ATS assembly shall be labeled by a Nationally Recognized Testing Laboratory (NRTL).
- E. Provide equipment that is IBC/CBC seismically qualified with seismic freestanding or wall mount label. Refer to Section 263213.13 – Diesel-Engine-Driven Generator Set for earthquake design data for the project site.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Inspect equipment and report concealed damage to carrier within their required time period.
- B. Handle equipment carefully and in accordance with manufacturer's recommendations to avoid damage to internal components, enclosure, and finish.
- C. Store equipment in a clean, dry indoor environment. Maintain factory packaging until time of installation. Cover with heavy canvas or plastic to keep out dirt, water, and construction debris. Heat enclosures to prevent condensation.

1.8 WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a minimum period of one (1) year from date of substantial completion of the project.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The ATS shall automatically transfer the assigned load (L) from the "Normal" (N) source to the "Emergency" (E) source upon a loss of normal source power and retransfer back again upon restoration of normal source power. The ATS shall transfer the load in both directions in "open transition" mode (break before make).
- B. The ATS unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices are not acceptable. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal and emergency.
- C. The ATS shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition.
- E. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- F. A neutral terminal plate with fully rated AL-CU pressure connectors shall be provided for solid connection of the utility, emergency and load neutral conductors.
- G. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.
- H. Inspection of all contacts (movable and stationary) shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors, to facilitate inspection and maintenance.
- I. A manual handle shall be provided for maintenance purposes with the switch de-energized. The handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly inspect and service the contacts when required.

- J. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection, or manual operation.
- K. A means shall be provided to manually operate the transfer switch in the event of switch failure.

2.2 RATING

- A. The ATS shall be rated for 100% continuous duty for all classes of inductive and non-inductive loads. The transfer switch shall be rated for 240 volts, 1-phase, 60 hertz, 2 pole, 3 wire. The ampere rating of the switch shall be as indicated on the Drawings.
- B. The ATS shall have 600-volt insulation on all parts in accordance with NEMA standards.
- C. The current rating shall be a 24-hour continuous rating when the switch is installed in an unventilated enclosure and shall conform to NEMA temperature rise standards.
- D. The thermal capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of 3 electrical cycles as established by certified test data.
- E. The minimum UL listed Withstand and Closing Ratings shall be 22,000 RMS symmetrical amperes at 240 volts, 60 Hz for 3 cycles. Before ordering the ATS, the SE rated enclosed main circuit breaker or the diesel engine-generator set, verify with ATS manufacturer that the SE rated enclosed main circuit breaker specified in Section 262816.13 – Enclosed Circuit Breakers and the generator output circuit breaker provided with the diesel-engine-driven generator set specified in Section 263213.13 – Diesel-Engine-Driven Generator Set will provide the required 22 kA RMS symmetrical withstand and closing rating for the ATS.
- F. The ATS shall be "fully rated." A "series rated" switch is not acceptable.
- G. Before ordering the ATS or the SE rated enclosed main circuit breaker specified in Section 262816.13 – Enclosed Circuit Breakers, confirm with the ATS manufacturer that the SE rated enclosed main circuit breaker will provide the required 22 kA RMS symmetrical withstand and closing rating for the ATS.

2.3 MICROPROCESSOR BASED CONTROLLER

- A. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, inherent serial communications capability, and the ability to communicate via an Ethernet connection through an optional communications module.
- B. A single controller shall provide single and three phase capability for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to ± 0.1 Hz. Time delay settings shall be accurate to $\pm 0.5\%$ of the full-scale value of the time delay. The panel shall be capable of operating over a temperature range of -20°C to 70°C and a storage temperature from -55°C to 85°C .
- C. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

- D. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. IEC 60947 – 6 – 1 Multiple Function Equipment Transfer Switching Equipment
 - a. IEC 61000-4 Testing and Measurement Techniques - Overview
 - b. IEC 61000-4-2 Electrostatic Discharge Immunity
 - c. IEC 61000-4-3 Radiated RF Field Immunity
 - d. IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
 - e. IEC 61000-4-5 Surge Immunity
 - f. IEC 61000-4-6 Conducted RF Immunity
 - 2. CISPR 11 – Conducted RF Emissions and Radiated RF Emissions
- F. Controller Display and Keypad
 - 1. A backlit 128*64 graphical LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through communications port. The following parameters shall only be adjustable via DIP switches on the controller.
 - a. Nominal line voltage and frequency
 - b. Single or three phase sensing on normal
 - c. Transfer operating mode configuration, (open transition, or delayed transition)
 - 2. All instructions and controller settings shall be easily accessible, readable, and accomplished without the use of codes, calculations, or instruction manuals.
 - 3. The 128*64 graphical display shall have multiple language capability. Languages can be selected from the user interface.

2.4 VOLTAGE AND FREQUENCY SENSING

- A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified).

<u>Parameter</u>	<u>Sources</u>	<u>Dropout/Trip</u>	<u>Pickup/Reset</u>
Undervoltage	N & E	70 to 98%	85 to 100%
Overvoltage	N & E	102 to 116%	2% below trip
Underfrequency	N & E	85 to 98%	86 to 100%
Overfrequency	N & E	101 to 111%	2% below trip

- B. Repetitive accuracy of all settings shall be within 1% at 25°C.
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

- D. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage and frequency. Single-phase sensing on the emergency source shall be provided.

2.5 TIME DELAYS

- A. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds. It shall be possible to bypass the time delay from the controller user interface. Initial setting for this time delay shall be 2 second.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes 59 seconds for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface. Initial setting for this time delay shall be 1 seconds.
- C. A generator stabilization time delay shall be provided after transfer to emergency adjustable 0 or 4 seconds. Initial setting for this time delay shall be 1 second.
- D. A time delay shall be provided on retransfer to normal, adjustable 0 to 9 hours 59 minutes 59 seconds. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable. Initial setting for this time delay shall be 10 minutes.
- E. A cooldown time delay shall be provided on shutdown of engine generator, Adjustable 0 to 60 minutes 59 seconds. Initial setting for this time delay shall be 0 if engine cooldown timer is included in the generator control panel. Otherwise, the initial setting for this time delay shall be 5 minutes.
- F. All adjustable time delays shall be field adjustable without the use of special tools.
- G. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes 59 seconds time delay in any of the following modes:
 - 1. Prior to transfer only
 - 2. Prior to and after transfer
 - 3. Normal to emergency only
 - 4. Emergency to normal only
 - 5. Normal to emergency and emergency to normal
 - 6. All transfer conditions or only when both sources are available
- H. If the alternate source is not accepted within the configured Failure to Accept time delay, the common alert indication shall become active.
- I. The controller shall also include the following built-in time delay for delayed transition operation:
 - 1. A time delay for the load disconnect position for delayed transition operation adjustable 0 to 5 minutes 59 seconds.

2.6 ENCLOSURE

- A. The ATS shall be furnished in a NEMA Type 3R steel hinged door enclosure with ANSI 49 or ANSI 61 light gray paint finish.
- B. Alternate Bid No. 1: Provide NEMA Type 4X, Type 304 stainless steel hinged door enclosure in lieu of the NEMA Type 3R enclosure.

- C. Enclosure shall be dead front type with outer door to conceal and protect the microprocessor-based controller unit from tampering and from the weather.
- D. Provide 125 watt thermostatically controlled (adjustable from 30°F to 140°F) strip heater wired to load terminals of ATS with NEC required overcurrent protection inside the enclosure to prevent condensation from forming. Set thermostat to 90°F.

2.7 ADDITIONAL FEATURES

- A. The automatic transfer switch shall include the following items as a minimum.
 - 1. Voltage sensitive relays for full voltage protection.
 - 2. A set of contacts rated 30VDC, 5A, for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cooldown setting, regardless of whether the normal source restores before the load is transferred.
 - 3. Two (2) auxiliary 120VAC, 10A, form "C" contacts which change state depending on the voltage source used.
 - 4. A single alarm indication shall light up the alert indicator and de-energize the configured common alarm output relay for external monitoring.
 - 5. LED indicating lights shall be provided to indicate the following:
 - a. Green to indicate switch is in NORMAL power position
 - b. Red to indicate switch is in the EMERGENCY power position
 - c. Green to indicate NORMAL power source is available
 - d. Red to indicate EMERGENCY power source is available
 - e. Amber to indicate NOT IN AUTO condition, and
 - f. Amber to indicate a common alarm ALERT condition
 - 6. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.
 - 7. LED indicating light shall be provided to indicate switch is not in automatic mode (manual); and blinking (amber) to indicate transfer inhibit.
 - 8. LED indicating light shall be provided to indicate any alarm condition or active time delay (red).
 - 9. A lamp test push button shall be provided on the user interface which shall test all indicator lights simultaneously.
 - 10. The user interface shall be provided with test/reset modes. The test mode shall simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.
 - 11. Ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
 - 12. Variable window in-phase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources. The in-phase monitor shall be specifically designed for and be the product of the ATS manufacturer.
 - 13. System Status Display: The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key. This screen shall display a clear description of the active operating sequences and switch position. Controllers that require multiple screens to determine system status or display

- “coded” system status messages, which must be interpreted by referring to the Operator’s Manual, are not acceptable.
14. Self-Diagnostics: The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
 15. Communications Interface: The controller shall be capable of interfacing, through an optional serial communication port with a network of transfer switches, locally (up to 4,000 feet). Standard software specific for transfer switch applications shall be available from the ATS manufacturer. This software shall allow for the monitoring, control, and setup of parameters.
 16. Data Logging: The controller shall have the ability to log data and to maintain the last 300 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in non-volatile memory.
 - a. Event Logging
 - i. Date, time, and reason for transfer from normal to emergency
 - ii. Date, time, and reason for transfer from emergency to normal
 - iii. Date, time, and reason for engine start
 - iv. Date, time, and reason engine stopped
 - v. Date and time emergency source available
 - vi. Date and time normal source available
 - b. Statistical Data
 - i. Total number of transfers
 - ii. Total number of transfers due to source failure
 - iii. Total number of days controller is energized
 - iv. Total number of hours both normal and emergency sources are available
 - v. Total time load is connected to normal
 - vi. Total time load is connected to emergency
 - vii. Last engine start
 - viii. Last engine run time
 - ix. Input and output status
 17. Fully programmable engine exerciser with seven independent routines to exercise the engine-generator with or without connected load, on a daily, weekly, bi-weekly, or monthly basis. Engine exerciser setting shall be displayed and shall be selectable from the user interface keypad.
 18. Factory mounted surge protective device (SPD) wired to the normal source lugs of the ATS to protect the ATS microprocessor controller from voltage transients with the following features:
 - a. Surge rating: 200kA per phase, 100kA per mode
 - b. UL 1449 4th Edition, Type 2
 - c. I nominal (I_n): 20kA
 - d. 100kA SCCR
 - e. Voltage protection ratings (VPR): 1000V L-L, 700V L-N, L-G, N-G
 - f. Maximum continuous operating voltage (MCOV): 276VAC L-L, 150VAC L-N, L-G, N-G
 - g. UL 1283 listed enhanced EMI/RFI filtering up to -50dB from 10kHz to 100MHz
 - h. Repetitive impulse: 5,000 hits
 - i. Less than 1ns response time

- j. Individually fused and thermally protected large block 50kA metal oxide varistors (MOVs)
- k. Solid state bi-directional operation
- l. 100% monitoring of all MOVs, including N-G
- m. LED status indication of normal operation, phase loss or component failure
- n. Form C dry contacts for external alarm or monitoring
- o. Enclosed in a NEMA Type 4X rated polycarbonate enclosure
- p. Relative humidity range: 0 – 95% non-condensing
- q. Operating temperature: -25°C (-15°F) to 60°C (150°F)
- r. Peak operating temperature: 85°C (185°F)
- s. Operating frequency: 47 – 63Hz
- t. ASCO Power Technologies Model 430120SP20ACAJ20 or approved equal by ABB-GE, Eaton, or Schneider Electric
- u. Provide 30A/2P, 25 kAIC rated circuit breaker inside the ATS as the disconnecting means for the SPD

2.8 NAMEPLATES

- A. All devices mounted on the transfer switch enclosure door, as well as individual items mounted inside the enclosure, shall be provided with a nameplate to show the identification and/or function of the device or item.
- B. All nameplates shall be engraved laminated plastic in accordance with Section 260553 - Identification for Electrical Systems. Unless otherwise indicated, all nameplates shall have 1/4-inch high characters.
- C. Provide a permanent factory equipment nameplate/label that provides pertinent information about the ATS including manufacturer, model number, order number, serial number, voltage, amperage, frequency, number of phases or switched poles, etc.

2.9 APPROVED MANUFACTURERS

- A. Subject to compliance with all requirements specified herein, provide products by one of the following:
 - 1. ASCO
 - 2. ABB-GE-Zenith
 - 3. Russelectric
- B. The design of the automatic transfer switch installation has been based on an ASCO Series 300 (Type 3ATS) automatic transfer switch. Should the Contractor choose to provide equipment from one of the approved equal manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories.

PART 3 - EXECUTION

3.1 FACTORY TESTS AND CERTIFICATION

- A. The automatic transfer switch, complete with the controller and all accessories, shall be listed by Underwriters' Laboratories, Inc. (UL), and shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification

requirements. The factory testing shall include a dielectric strength test per NEMA Standard ICS1-109.21.

- B. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall submit test data for each switch, verifying that the switch can withstand, without damage, fault currents of the magnitude and the duration necessary to maintain the system integrity.

3.2 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's written instructions.
- B. Mount equipment on stainless steel U-channel support rack, using stainless steel fasteners as indicated on the Drawings.
- C. All power and control conduits shall enter/exit the bottom, sides or back of the equipment enclosure at the locations indicated on the equipment drawing. There shall be no penetrations in the top of the enclosure.
- D. All conduit connections to the equipment shall be made using an insulated, grounding type threaded conduit hub in accordance with Specification Section 260533.13 – Conduit for Electrical Systems.
- E. Connect power conductors and control cables to equipment as indicated on the equipment drawings and torque all terminations in accordance with the equipment manufacturers recommendations.
- F. Remove rust from all scratches on ATS enclosure and door and touch-up the paint finish using manufacturer provided touch-up paint in an aerosol spray can.

3.3 ARC FLASH HAZARD WARNING LABELS

- A. Provide an arc flash hazard warning label on front exterior of the enclosure of the ATS in accordance with Sections 260553 - Identification for Electrical Systems and 260573 – Protective Device Coordination Study and Arc Flash Risk Assessment.

3.4 STARTUP AND COMMISSIONING

- A. Provide startup and commissioning of the equipment by a factory authorized and factory trained field startup technician.
- B. The normal and emergency power supplying the automatic transfer switch shall be tested for comparable phase relationships.
- C. The automatic transfer switch shall have its normal power interrupted in order to insure fully automatic shifting of power from its normal source to emergency power.

- D. The transfer switch shall be tested for operation below 85% rated voltage. Also test the contacts and signal that activates the diesel-engine-driven generator set and confirm the closing of the emergency contacts when the generator is up to 90% rated voltage.
- E. Adjust voltage and frequency settings as required for optimal operation and adjust timing relays as required to ensure the generator starts and the load is transferred to the generator within a maximum of 10 seconds from loss of normal utility power as required by NFPA 110.
- F. All LED indicators on the controller shall be tested for correct operation and sequence.
- G. Test functional operation of the automatic transfer switch in all modes of operation.
- H. Repair and retest until equipment is fully functional as designed.
- I. All testing shall be performed in the presence of and approved by the Construction Representative.
- J. Provide field startup report for Owner's records indicating the date and time and name of the technician who performed the equipment startup and commissioning services.

3.5 OWNER TRAINING

- A. A factory authorized and trained field service technician shall instruct the Owner's maintenance personnel on the proper operation of the automatic transfer switch in both manual and automatic modes and on preventative maintenance and servicing of all Owner serviceable components.

END OF SECTION 263623

SECTION 265113 – INTERIOR LIGHTING FIXTURES, LAMPS AND DRIVERS

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 remove existing lighting fixtures in the air lock room and air lock tunnel entrance to the cave and shall furnish and install new lighting fixtures and lamps as specified herein and as shown on the Drawings.
- B. This section does not apply to lighting fixtures located within the cave. See Section 265613 – Cave Lighting Fixtures, Power Supply Units and Drivers for cave lighting fixture requirements.

1.3 RELATED SECTIONS

- A. Section 260500 – Common Work Results for Electrical
- B. Section 260505 – Selective Demolition for Electrical
- C. Section 260519 – Low-Voltage Electrical Power Conductors and Cables
- D. Section 260529 – Hangers and Supports for Electrical Equipment
- E. Section 260533.13 – Conduit for Electrical Systems
- F. Section 260533.16 – Boxes for Electrical Systems
- G. Section 260583 – Wiring Connections

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for each type of the following:
 - 1. Lighting fixtures
 - 2. Lighting fixture lamps, LEDs, and drivers
- B. Provide dimensions, ratings, performance data, including luminaire photometric data, accessories, installation instructions and any production application conditions and limitations of use stipulated by the product testing agency.
- C. Record Drawings: Accurately record the actual installed location of each lighting fixture.

1.5 SUBSTITUTIONS

- A. The Contractor shall base his Base Bid on the first named lighting fixture manufacturer for each lighting fixture type specified in the "New Lighting Fixture Schedule" on the Drawings. For each fixture type, only products of manufacturers listed in the "manufacturers catalog number" column of the fixture schedule or the specifications, which meet or exceed the performance, fabrication

and aesthetics of the first named fixture shall be considered an equal. Lighting fixture “equals” may be submitted for review as part of the shop drawing submittal process.

- B. Lighting fixtures from alternate manufacturers not listed in the lighting fixture schedule or the specifications shall be submitted to the Designer for review as a substitution prior to bid submittal in accordance with the requirements below and Section 007213 – General Conditions and Section 007300 – Supplementary Conditions. The Designer reserves the right to reject any substitution submittal.
- C. All requests for lighting fixture substitutions submitted to the Designer for approval must be accompanied by a lighting fixture comparison sheet(s) that documents equivalency of the substituted fixture and the specified fixture and includes a detailed list of all differences. Requests for substitution that are not accompanied by the required comparison sheet(s) will be rejected.
- D. Each comparison sheet(s) must include the following data for both the specified lighting fixture and the substituted lighting fixture.
 - 1. Photometric Data – Include candle power table, coefficient of utilization table, lighting distribution table and maintained illumination table. Photometric data must be based on the same LED CCT, CRI, lumens and distribution type as the specified fixture and ceiling-wall-floor reflectances of 50-50-20 for unfinished spaces with a light loss factor of .72.
 - 2. Product Data – Provide data on lighting fixture dimensions, construction, finish, color, mounting, louver, lens, diffuser, reflector, lamps, ballasts, accessories, and options as applicable.

1.6 EXTRA MATERIALS

- A. Provide one (1) spare LED driver for each size and type used on this project.
- B. Provide one (1) spare LED strips/lamp modules for each size and type used on this project.
- C. Provide one (1) spare lamp for every two (2) lamps installed for each size and type used on this project. Provide one (1) spare lamp if only one of a particular size and type of lamp is used on the project.
- D. No spare parts are required for the Type W lighting fixture.

1.7 WARRANTY

- A. All products specified in this Section shall carry a minimum 5-year manufacturer’s full no cost replacement warranty from the date of Substantial Completion.
- B. Manufacturers and installer agree to repair or replace component parts of lighting fixtures that experience a failure in materials or workmanship, including the fixture’s finish, within the warranty period. The entire luminaire shall be replaced, if necessary, to correct the failure.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

- A. Lighting fixtures shall be specified in the “New Lighting Fixture Schedule” on the Drawings. The “New Lighting Fixture Schedule” specifies the quality and standards required. Lighting fixture manufacturers frequently change their catalog numbers and therefore the catalog numbers listed in the lighting fixture schedule may not be complete or may be incorrect. The Contractor shall

be responsible for submitting lighting fixtures that comply with the catalog numbers listed as well as all requirements stipulated in the lighting fixture schedule, Drawing notes and the specifications. The Contractor/manufacturer shall contact the Designer prior to submitting his bid, regarding any conflicts between the catalog number, lighting fixture schedule or specifications.

- B. Only one manufacturer shall be used for each fixture type listed in the lighting fixture schedule for the entire project.
- C. Lighting fixtures shall be equipped with proper accessories, lenses, louvers, reflectors, shields, globes, mounting brackets, hangers, clips, frames, lamps, drivers, heat sinks, controllers, connectors, fuses, and other essentials for proper installation in or upon walls, ceilings or other construction features and shall be properly painted or coated for protection and preservation appropriate to the location where installed.
- D. All fixtures with integral LED drivers shall have GLR fusing and a driver disconnect device.
- E. Fixture assemblies, including cords, LED drivers, power hooks, plugs, safety chain, etc., shall be UL labeled and shall be mounted as shown on the Drawings.
- F. Where a fixture requires an external cord, the cord shall be 105°C, Type ST, 3-conductor, size 14 AWG copper wire, rated for 600 volts.
- G. All fixtures shall be Underwriters' Laboratory (UL) listed and labeled "Suitable for Wet Locations" and all metal parts and mounting screws shall be stainless steel.

2.2 LED LIGHTING FIXTURES

- A. Provide all system components including, but not limited to, LED lamp modules, drivers, heat sinks, controllers, and connectors for a complete and operational system.
- B. Each LED luminaire type shall be binned to within a three-step McAdam ellipse to ensure color consistency among luminaires.
- C. Enclosed & Gasketed LED lighting fixtures shall meet the following minimum requirements:
 - 1. GLR fusing
 - 2. >80 CRI
 - 3. 3000K CCT
 - 4. 60,000-hour LED life at 80% lumen maintenance (L80)
 - 5. Power factor > 0.95
 - 6. Max THD < 20%
 - 7. Luminaire surge protection level: Designed to withstand up to 6kV/3kA per ANSI C82.77-5-2015
 - 8. Fiberglass housing with poured-in-place NEMA 4X gasketed.
 - 9. Injection molded 0.080" thick lineal ribbed, frosted, impact resistant acrylic lens with stainless steel latches
 - 10. IP67 / NEMA Type 4X wet location environmental rating
 - 11. -35°C (-31°F) to 25°C (77°F) ambient temperature rating
 - 12. Other requirements, including accessories, as indicated in the "New Lighting Fixture Schedule" on the Drawings.

2.3 LIGHTING FIXTURE LAMPS

- A. All lamps shall be furnished and installed by the Contractor as part of the work herein and shall be in proper operating condition when turned over to the Owner. Lamp types shall be as indicated on the “New Lighting Fixture Schedule” on the Drawings.
- B. LED Screw Base B11 lamps:
 - 1. Correlated color temperature (CCT): 2700°K
 - 2. Operating voltage: 120VAC, 60 Hz
 - 3. Color rendering index (CRI): ≥ 80
 - 4. Lamp wattage: ≤ 5
 - 5. Power factor: ≥ 0.9
 - 6. Lumens: ≥ 450
 - 7. Rated life: L70 $\geq 15,000$ hours
 - 8. Lamp shape: B11
 - 9. Base: E26
 - 10. Minimum starting temperature: $\leq -20^{\circ}\text{C}$ (-4°F)
 - 11. Maximum operating temperature: $\geq 40^{\circ}\text{C}$ (104°F)
 - 12. UL Listed for damp locations
 - 13. Suitable for totally enclosed fixtures
 - 14. Omni-directional beam spread: $\geq 320^{\circ}$
 - 15. Dimmable to 10°
 - 16. Manufacturer: Eiko Cat. No. LED5WB11E26/FIL/827K-DIM-G7 or approved equal by Satco, TCP, Inc., or Westinghouse

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. All lighting fixtures shall be installed in accordance with the NEC and in strict accordance with the lighting fixture manufacturer’s written instructions.
- B. Set fixtures level, plumb, and square with ceilings and walls and secure according to the manufacturer’s written instructions, approved submittal materials and/or as shown in the details on the Drawings.
- C. Connections within each lighting fixture shall be made using electrical twist-on spring connectors in accordance with Section 260583 – Wiring Connections.
- D. Install lamps in each fixture of the proper size, type and quantity indicated in the “New Lighting Fixture Schedule” on the Drawings.

3.2 ENCLOSED AND GASKETED FIXTURE INSTALLATION

- A. Surface mount lighting fixtures to ceiling with factory provided stainless steel mounting brackets, one at each end of the fixture, in locations indicated on the Drawings. Do not drill mounting holes in lighting fixture housings.
- B. Do not drill conduit entry holes in lighting fixture housings. Use only factory furnished fittings for conduit connections.

3.3 FIELD QUALITY CONTROL

- A. Visually inspect each lighting fixture housing for manufacturing flaws or misalignment of components such as gaskets, hinges, and lenses prior to installation. Fixtures shall also be inspected for cracks, holes or poor finish that will cause entry of moisture thereby reducing the life of the lighting fixture. Damaged lighting fixtures shall be rejected and returned to the supplier for a replacement.
- B. Inspect each installed fixture for damage. Replace damaged fixtures, inoperable lamps, and components.
- C. Test all lighting fixtures in the presence of the Construction Representative for proper operation.
- D. Malfunctioning Fixtures and Components: Repair or replace and retest. Repeat procedure until all units operate properly.

3.4 CLEANING AND ADJUSTING

- A. Fixtures shall be properly protected from damage or marring during construction until final acceptance by the Construction Representative.
- B. Fixtures, lamps, lenses, and enclosures shall be cleaned using methods and materials recommended by the fixture manufacturers and all lamps and LED arrays/modules shall be in working order prior to final acceptance by the Construction Representative.

END OF SECTION 265113

SECTION 265613 – CAVE LIGHTING FIXTURES, POWER SUPPLY UNITS AND DRIVERS

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 remove all existing lighting fixtures inside the Onondaga Cave and shall furnish and install new lighting fixtures, power supply units and drivers as specified herein and as shown on the Drawings.
- B. This section does not apply to lighting fixtures located within the air lock room and air lock tunnel entrance to the cave. See Section 265113 – Lighting Fixtures, Lamps and Drivers for the requirements for those lighting fixtures.

1.3 RELATED SECTIONS

- A. Section 260500 – Common Work Results for Electrical
- B. Section 260505 – Selective Demolition for Electrical
- C. Section 260519 – Low-Voltage Electrical Power Conductors and Cables
- D. Section 260529 – Hangers and Supports for Electrical Equipment
- E. Section 260533.13 – Conduit for Electrical Systems
- F. Section 260533.16 – Boxes for Electrical Systems
- G. Section 260583 – Wiring Connections
- H. Section 20943.23 – Relay-Based Lighting Controls
- I. Section 321413 – Precast Concrete Unit Pavers

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for each type of the following:
 - 1. Lighting fixtures, including all accessories and mounting hardware
 - 2. Lighting fixture power supply units and drivers
 - 3. Lighting fixture cable gland fittings for PSU and driver enclosures
 - 4. Lighting fixture LED lamp modules
 - 5. Material to be used for field fabrication of the cave feature lighting shrouds
 - 6. Indicating silica gel, moisture absorbing desiccant canisters
- B. Provide dimensions, ratings, performance data, including luminaire photometric data, accessories, installation instructions and any production application conditions and limitations of use stipulated by the product testing agency.

- C. Provide a copy of the manufacturer's installation instructions for each type of lighting fixture, power supply unit and driver.
- D. Cave Guardrail LED Linear Lighting Shop Drawings:
 - 1. Submit a copy of the lighting fixture manufacturer's order sheet to be used by the Contractor to indicate the configuration of each serially connected set of cave guardrail LED linear lighting fixtures.
 - 2. Provide drawings showing the configuration of each cave guardrail LED linear lighting circuit segment, as ordered by the Contractor using the lighting fixture manufacturer's order sheet, using the cave electrical plan background drawings. Drawings shall indicate driver locations, the length of each lighting fixture segment and jumper.
 - 3. Provide schematic showing the electrical interconnection of segments and the connection of each group of segments to the driver. Indicate, the power load of each serially connected group of lighting fixture segments and the total power load on each driver.
 - 4. The group of serial connected segments shall be labeled per the Type T fixture designation on the Drawings and on the manufacturer's product packaging to ensure accurate installation in the field. Each individual lighting fixture segment of each Type T lighting fixture serial connected group shall be labeled on the shop drawings.
- E. Installation, Operation and Maintenance Instructions: Submit installation, operation and maintenance instructions for each type of lighting fixture, power supply unit and driver in accordance with Section 007123 – General Conditions and Section 017823 – Operation and Maintenance Data.
- F. Record Drawings: Accurately record the actual installed location of each lighting fixture in the cave.

1.5 SUBSTITUTIONS

- A. The Contractor shall base his Base Bid on the first named lighting fixture manufacturer for each lighting fixture type specified in the "New Lighting Fixture Schedule" on the Drawings. For each fixture type, except those noted as having "no approved equal", only products of manufacturers listed in the "manufacturers catalog number" column of the lighting fixture schedule or the specifications, which meet or exceed the performance, fabrication and aesthetics of the first named fixture shall be considered an equal. Lighting fixture "equals" may be submitted for review as part of the shop drawing submittal process.
- B. Lighting fixtures from alternate manufacturers not listed in the lighting fixture schedule or the specifications shall be submitted to the Designer for review as a substitution prior to bid submittal in accordance with Section 012500 – Substitution Procedures using the form provided in Section 006325 – Product Substitution request and in accordance with the requirements in Paragraph 1.5 C below. The Designer reserves the right to reject any substitution submittal.
- C. All requests for lighting fixture substitutions submitted to the Designer for approval must be accompanied by a lighting fixture comparison sheet(s) that documents equivalency of the substituted fixture and the specified fixture and includes a detailed list of all differences. Requests for substitution that are not accompanied by the required comparison sheet(s) will be rejected.

1.6 EXTRA MATERIALS

- A. Furnish extra materials for Owner's "attic stock" of the same makes and models installed and that are packaged for safe storage and clearly identified and labeled to accurately describe the package contents.
1. Lighting Fixtures: Provide the following complete spare lighting fixtures:
 - a. Provide four (4) Type B lighting fixtures
 - b. Provide three (3) Type C lighting fixtures
 - c. Provide seven (7) Type D lighting fixtures
 - d. Provide two (2) of each Type T lighting fixture length that has a minimum quantity of 10 used on this project. Spare Type T fixtures shall have a 24" long 2/C#18 Type SJTW cable, white jacket with stranded copper leads, potted to lighting fixture body on each end to allow splicing to the existing fixture on either side of the one being replaced in Owner furnished IP68 splice boxes.
 2. LED drivers: Provide six (6) spare LED drivers for each size and type used on this project that is user replaceable.
 3. Power supply units: Provide three (3) spare LED cave feature lighting fixture power supply units of both types used on this project.
 4. LED arrays and modules: Provide three (3) spare LED strips/lamp modules for each size and type used on this project that is user replaceable.
 5. Lighting fixture accessories:
 - a. Provide 4 spare Type B lighting fixture snoots
 - b. Provide 8 spare Types C & D lighting fixture snoots
 - c. Provide 4 spare Type B lighting fixture tripods
 - d. Provide 8 spare Type C & D lighting fixture tripods
 - e. Provide 6 spare luminaire insulators
 6. Fuses: Provide 10%, minimum of three (3), of each size and type

1.7 WARRANTY

- A. All products specified in this Section shall carry a minimum of a 5-year manufacturer's full no cost replacement warranty from the date of Substantial Completion.
- B. Manufacturers and installer agree to repair or replace component parts of lighting fixtures that experience a failure in materials or workmanship, including the fixture's finish, within the warranty period. The entire luminaire shall be replaced, if necessary, to correct the failure.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

- A. Lighting fixtures shall be provided as specified in the "New Lighting Fixture Schedule" on the Drawings. The "New Lighting Fixture Schedule" specifies the quality and standards required. Lighting fixture manufacturers frequently change their catalog numbers and therefore the catalog numbers listed in the lighting fixture schedule may not be complete or may be incorrect. The Contractor shall be responsible for submitting lighting fixtures that comply with the catalog numbers listed as well as all requirements stipulated in the lighting fixture schedule, Drawing notes and the specifications. The Contractor/manufacturer shall contact the Designer prior to

submitting his bid, regarding any conflicts between the catalog number, lighting fixture schedule or specifications.

- B. Only one manufacturer shall be used for each fixture type listed in the lighting fixture schedule for the entire project.
- C. Lighting fixtures shall be equipped with proper accessories, lenses, louvers, reflectors, shields, globes, mounting brackets, hangers, clips, frames, lamps, drivers, heat sinks, power supplies, controllers, connectors, fuses, and other essentials for proper installation inside the cave were indicated on the Drawings and shall be properly painted or coated for protection and preservation appropriate to the location where installed.
- D. All fixtures with LED driver(s) shall have GLR, or manufacturer's standard fast-blow, field replaceable fusing. If fusing integral to a particular lighting fixture cannot be provided from the factory, include information on the type of overload, short circuit and ground fault protection provided for each of these types of lighting fixtures with the shop drawing submittal.
- E. Fixture assemblies, including cords/cables, LED drivers, mounting brackets, and other accessories, shall be UL listed and labeled and shall be mounted as shown on the Drawings.
- F. Lighting fixture external power/control cables shall be provided as required by the fixture manufacturer. All cables shall have stranded copper conductors and shall be 600-volt rated with a minimum continuous duty rating of 90°C.
- G. All fixtures shall be Underwriters' Laboratory (UL) listed and labeled IP68, IP69 or NEMA Type 6P and all metal parts, accessories and mounting hardware shall be stainless steel.

2.2 CAVE FEATURE LED LIGHTING FIXTURES

- A. All lighting fixtures used to illuminate features within the cave shall be specifically designed for such use and shall be "cave hardened" to withstand the harsh conditions present in cave environments, 95% to 100% condensing humidity, chemistry that is corrosive to aluminum, organisms that grow on many types of plastics and electrical surges caused by dissipation of lightning strikes through the earth. In addition, the cave feature LED lighting fixtures must be suitable for continuous operation while submerged in up to 20 feet of water or when installed without being submerged in any amount of water in a constant ambient temperature of 58°F.
- B. Provide all required system components including, but not limited to, LED lamp modules, drivers, heat sinks, power supply units, controllers, cables, connectors, mounting accessories and glare shields for a complete and operational system.
- C. Cave feature lighting fixtures, Types B, C, D and DS shall be provided as indicated in the "New Lighting Fixture Schedule" on the Drawings.
- D. Cave feature lighting fixtures shall meet the following minimum requirements:
 - 1. LEDs binned to within 3 Macadam ellipses
 - 2. Correlated Color Temperature (CCT): 3000K
 - 3. CRI: >80
 - 4. Lumen Output:
 - a. Types B: 700 lumens
 - b. Types C, D & DS: 3,259 lumens

5. Lumen Maintenance (L70): 150,000 hours (25°C)
6. Construction: Type 316 marine grade stainless steel with powder-coated black finish
7. Beam Angles: As indicated in the “New Lighting Fixture Schedule” on the Drawings
8. External lens:
 - a. Types B, C, D & DS: Tempered glass
9. Input Voltage: 24VDC, constant current
10. Voltage Dips/Interruptions: 70% for 10 cycles, 30% for 0.5 cycles
11. Fast Transient: ±4kV
12. Surge: ±2kV
13. Electrostatic Discharge:
 - a. Air Discharge: ±8kV
 - b. Contact Discharge: ±4kV
14. Approved Use: IP68 rating, continuously submersible to a depth of 20 feet and rated for continuous operation when not submersed
15. UL Listing: UL 2108 Standard for Safety Low Voltage Lighting Systems
16. Operating Temperature: -40°F (-40°C) to 122°F (50°C)
17. Surface Temperature: < 122°F (50°C) at 77°F (25°C) ambient
18. Control: DMX via separate power supply unit
19. Connection: 98.4’ (30m) 5/C#18 stranded copper STOW cable
20. Warranty: 5 years
21. Accessories (as indicated in the “New Lighting Fixture Schedule” on the Drawings):
 - a. Types B, C, D & DS:
 - i. 226mm diameter tripod, Type 316 stainless steel with powder-coated black finish and non-conductive feet (for use with Type B fixtures). Provide Type 316 stainless steel mounting hardware with powder-coated black finish to attach tripod to lighting fixture yoke.
 - ii. 306mm diameter tripod, Type 316 stainless steel with powder-coated black finish and non-conductive feet (for use with Types C & D lighting fixtures). Provide Type 316 stainless steel mounting hardware with powder-coated black finish to attach tripod to lighting fixture yoke.
 - iii. 3” Snoot, Type 316 stainless steel with powder-coated black finish
 - iv. Luminaire Insulator:
 - 1) Application: Insulating luminaire from ground
 - 2) Construction: Epoxy insulator
 - 3) Structure: Flanged post insulator
 - 4) Dry Lightning Impulse Withstand Voltage: > 11kV
22. Power Supply Units (PSUs):
 - a. Input Power: 100-277VAC, 50/60Hz
 - b. Output Power:
 - i. Type A PSUs: 150W total, 350mA or 700mA constant current, dip switch selectable, 4 control channels max per port

- ii. Type B PSUs: 400W total, 350mA or 700mA constant current, dip switch selectable, 4 control channels max per port
 - c. Power Factor: ≥ 0.97 at 120VAC
 - d. Max THD: $< 20\%$ at 50% load and 115VAC
 - e. Protection:
 - i. If unit is provided with fuse protection, the fuse shall be user replaceable
 - ii. Integral overcurrent and short circuit protection (auto-resetting after overcurrent condition/fault removed)
 - iii. Overtemperature (auto-resetting)
 - iv. Output overvoltage (requires power off/back on to reset)
 - f. Output Connections:
 - i. Type A PSUs: Up to 4 constant current connections via removable multi-pin terminal blocks
 - ii. Type B PSUs: Up to 8 constant current connections via removable multi-pin terminal blocks
 - g. Flicker free dimming of luminaires down to $\leq 5\%$ of full light output
 - h. Approvals:
 - i. Type A PSUs: UL 60950
 - ii. Type B PSUs: UL 62368
 - i. Enclosure Rating: IP20, dry location (to be installed in an IP68 submersible enclosure by Contractor)
 - j. Control: DMX via removable multi-pin terminal blocks or XLR connectors
 - k. All PSUs shall include a standalone “manual” mode that will allow manual dimming of all ports on the power supply as one group via dip switches.
 - l. Warranty: 5 years
23. Indicating Silica Gel, Moisture Absorbing, Reusable Desiccant Canisters:
- a. To be field installed in the IP68 enclosure for each PSU.
 - b. 40 grams of cobalt chloride-free, non-toxic and odorless desiccant gel beads.
 - c. Non-metallic or aluminum enclosure with removeable lid to provide access to desiccant beads for drying or replacement and with viewing window to allow bead color to be observed.
 - d. Orange gel beads shall turn dark green when saturated with moisture to indicate reactivating (drying) or replacement is required.
 - e. Gel beads shall be able to absorb 40% of their weight in water vapor
 - f. Include user manual with instruction for drying moisture saturated desiccant beads.
24. Other requirements, including accessories, as indicated in the “New Lighting Fixture Schedule” on the Drawings.

E. Approved manufacturers for cave feature LED lighting fixtures:

- 1. Fixture Type B (small 40° X 40° flood):
 - a. Acclaim AQP-211-AHCN

- b. No approved equal
- 2. Fixture Type C (large 10° X 10° spot):
 - a. Acclaim AQP-211-CCCN
 - b. No approved equal
- 3. Fixture Types D & DS (large 40° X 40° flood):
 - a. Acclaim AQP-211-CHCN
 - b. No approved equal
- 4. Approved manufacturers for cave feature LED lighting fixture power supply units:
 - a. Type A PSU: Acclaim Aqua Driver 150 ADR157
 - b. Type B PSU: Acclaim Aqua Driver 400 ADR400
 - c. No approved equals

2.3 SUBMERSIBLE CAVE FEATURE LED LIGHTING FIXTURES

- A. Cave feature lighting fixtures shown on the Drawings to be submerged in a water pool shall be Type DS and shall be provided as indicated in the “New Lighting Fixture Schedule” on the Drawings.
- B. The Type DS lighting fixtures shall meet all requirements of the Type D lighting fixtures above except that they will be installed submerged in water. All other cave feature lighting fixtures will be installed above the water except during seasonal flooding that occasionally occurs in the cave.

2.4 CAVE GUARDRAIL LED LINEAR LIGHTING FIXTURES

- A. All lighting fixtures used to illuminate walking trails within the cave shall be LED linear light suitable for mounting on a horizontal tubular stainless-steel guardrail.
- B. Provide all required system components including, but not limited to, LED lamp modules, drivers, heat sinks, power supply units, controllers, cables, connectors, mounting accessories and glare shields for a complete and operational system.
- C. Cave walking trail lighting fixtures, Type T, shall be provided as indicated in the “New Lighting Fixture Schedule” on the Drawings.
- D. Cave walking trail lighting fixtures shall meet the following minimum requirements:
 - 1. LEDs binned to within 3 Macadam ellipses
 - 2. Correlated Color Temperature (CCT): 3000K
 - 3. CRI: > 90
 - 4. Lumen Output: 20 Lm/ft
 - 5. Wattage: 0.5 W/ft
 - 6. Max Length: 65 total lineal feet, no including jumpers between fixtures
 - 7. LED Chips: 60 per foot
 - 8. LED Chip Beam Angle: 120°
 - 9. Luminous Efficacy (lm/w): 40 lm/W
 - 10. Lumen Maintenance (L70): >50,000 hours
 - 11. Construction: UV/IR protected thermoplastic polyurethane (TPU) flame retardant outer jacket with flexible copper PCB, V-0 rated, UL rated

12. Operating Voltage: 24VDC constant
13. Approved Use: IP69 rating, submersible to 25' depth for 72 hours
14. UL Listing: UL 2108 low voltage lighting system
15. Ambient Temperature: -4°F (-20°C) to 122°F (50°C)
16. Operating Temperature: -4°F (-20°C) to 176°F (80°C)
17. Constant output
18. Connection:
 - a. Driver Connection: 2/C#18 Type SJTW, white jacket with stranded copper leads, ≥ 6', potted to lighting fixture body to maintain submersible, IP69 rating
 - b. Fixture to Fixture Jumpers: 2/C#18 Type SJTW, white jacket with stranded copper leads, length as ordered (approximately 15 to 36 inches), potted to lighting fixture bodies to maintain submersible, IP69 rating
19. Mounting Hardware:
 - a. Straight Channel: PVC, color to match stainless steel guardrail tubes, for use everywhere except where bends in guardrail tube is too tight to allow the PVC channel to be clamped tight to the tube
 - b. Spin Channel: Type 304 stainless steel, for use where guardrail tube bends are too tight to allow the PVC channel to be clamped tight to the tube
 - c. Guardrail Tube Mounting Clamps: Type 304 stainless steel Type H conduit clamp, sized to fit the nominal 1-1/2" Schedule 40 Type 304 stainless steel guardrail horizontal tubes. Provide with Type 304 stainless steel clamp bolt and acorn nut.
20. Warranty: 5 years
21. Drivers:
 - a. Input Voltage/Frequency: 120-277VAC, 47 to 63Hz
 - b. Maximum Input Current (Full Load): 1.16A @ 120VAC
 - c. Maximum Inrush Current: 33.6A, 720 μs @ 120VAC
 - d. Power Factor: > 0.9 @ 120VAC
 - e. Efficiency: 93% @ 120VAC
 - f. Maximum Output Power: 96W
 - g. Maximum Output Current (Full Load): 4.0A
 - h. Output Voltage: 24VDC ±5%
 - i. Protections: Auto reset breakers for short circuit, overload and over temperature
 - j. Surge Protection: ≥ 3 kV
 - k. Ambient Temperature: -22°F (-30°C) to 158°F (70°C)
 - l. Operating Temperature: -4°F (-20°C) to 122°F (50°C)
 - m. Humidity: 5 – 95% RH, non-condensing
 - n. Environment: Indoor / Damp, IP20 rated case with silicone-based potting installed by the manufacturer in a Stahlin PC806 IP68 submersible enclosure with BP86FG fiberglass inner back panel with one or two (as ordered) IP68 lighting fixture cable gland fittings factory mounted in the enclosure
 - o. Output Cable Connections: Provide one (1) or two (2) (as ordered) IP68 straight nylon cable gland fittings factory installed in each driver enclosure; Kable Kontrol, SAB North America or approved equal
 - p. Cooling: Free-air convection
 - q. Total Harmonic Distortion (THD): < 10%
 - r. Certifications: UL Listed and Labeled, Class 2, Class P
 - s. Control: Constant voltage
 - t. Primary Leads: UL 1015 2#18AWG stranded copper, AC/L (Black), AC/N (White)

- u. Secondary Leads: UL 1007 2#18AWG stranded copper, V+(Red), V-(Blue)
 - v. Warranty: 5 years
22. Indicating Silica Gel, Moisture Absorbing, Reusable Desiccant Canisters:
- a. To be field installed in the IP68 enclosure for each driver.
 - b. 40 grams of cobalt chloride-free, non-toxic and odorless desiccant gel beads.
 - c. Non-metallic or aluminum enclosure with removeable lid to provide access to desiccant beads for drying or replacement and with viewing window to allow bead color to be observed.
 - d. Orange gel beads shall turn dark green when saturated with moisture to indicate reactivating (drying) or replacement is required.
 - e. Gel beads shall be able to absorb 40% of their weight in water vapor
 - f. Include user manual with instruction for drying moisture saturated desiccant beads
- E. Approved manufacturers for LED linear lighting:
- 1. DiodeLED DI-SO-24V-3D-AT-20-30-Length (2" to 192")
 - 2. No approved equal
- F. Approved manufacturers for LED linear lighting drivers:
- 1. DiodeLED VLM100W-24
 - 2. No approved equal

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. All lighting fixtures shall be installed in accordance with the NEC and in strict accordance with the lighting fixture manufacturer's written instructions.
- B. Mount lighting fixtures in accordance with the details shown on the Drawings.

3.2 CAVE FEATURE LED LIGHTING FIXTURE INSTALLATION

- A. Prior to installing any lighting fixtures or PSUs, mark the proposed installation location of each lighting fixture and PSU for each lighting circuit with survey flags in areas where the cave floor is mud and large steel washers painted orange or yellow for all other areas. Flag and washer color shall be as follows:

- 1. Lighting fixtures: Orange
- 2. PSUs: Yellow

The park superintendent, or his designated representative, must approve the lighting fixture and PSU location markings before the Contractor proceeds with the installation of each cave lighting circuit.

- B. *Pre-Installation Conference*: Provide a minimum of 6 hours of on-site instruction by an authorized field service representative of the cave feature lighting fixture manufacturer after the lighting equipment is delivered to the project site but before installation has begun to train the Contractor's installation personnel on the proper handling, installation and connection of the cave feature lighting fixtures and PSUs.

- C. Each cave lighting fixture is provided with a 98.4” long 5/C#18 stranded copper STOW cable that is factory wired to the fixture. This cable must not be disconnected from the lighting fixture or cut shorter.
- D. In locations indicated on the Drawings where it is believed the factory 98.4” long lighting fixture cable will be too short to reach the fixture’s PSU, a NEMA 6P/IP68 junction box is to be installed with up to 50’ of 5/C#12 stranded copper cable to extend the factory cable to the PSU. Splice wiring inside the junction box using 3M Performance Plus twist-on, spring-type connectors with 3M No. 3570 epoxy resin sealing packs in accordance with Section 260583 – Wiring Connections.
- E. Install lighting fixtures, PSUs, and all lighting fixture accessories in strict accordance with the lighting fixture manufacturer’s instructions and as indicated on the Drawings.
- F. The cave feature LED lighting fixtures are Type 316 stainless steel with a black powder coat finish. Paint adhesion on stainless steel is difficult. Therefore, great care shall be used at all times when handling and installing the lighting fixtures to avoid damage to the paint finish.
- G. Lighting fixtures shall be electrically isolated from the surface to which they are mounted in accordance with the details on the Drawings as follows:
 - 1. Cave Floor: Use factory provided tripod with non-conductive feet
 - 2. Concrete Pavers: Use factory provided luminaire insulator
 - 3. Paved Walking Trail, Elevated Catwalk or Other Structural Support: Use factory provided luminaire insulator
- H. Luminaire Insulator Installation:
 - 1. Drill two holes in mounting surface, typically a concrete paver, using an appropriately sized masonry bit without percussion and secure insulator using plastic anchor plugs with #12x1½” Type 304 stainless steel pan-head sheet metal screws.
 - 2. Secure lighting fixture mounting brackets or yoke to top of insulator using the appropriately sized Type 304 stainless steel machine screw, flat washer and split washer.
- I. Lighting fixtures using the factory tripod shall not be secured to the cave floor by any means, including the placing of cave rocks on the legs of the tripods. Instead, secure the luminaire cable to the cave floor, using a means acceptable to the Park Naturalist, within 6 to 8 inches of the luminaire.
- J. Initially, the 98.4’ factory lighting fixture cable shall be routed from the approved installation location of the lighting fixture to the approved location of its PSU in the most concealable path available but the cable shall not be cut shorter. During startup and commissioning of the lighting system, the final installation location for each lighting fixture will be determined as part of the aiming of the lighting fixture and the cable routing adjusted if/as required but it shall not be cut shorter. Any excess cable shall be coiled in a concealable location acceptable to the Park Naturalist. Lighting fixture cables will be concealed with cave mud/rocks by others after the installation is complete.
- K. The factory provided Type STOW lighting fixture cables may be run in water. However, where the factory 5/C#18 cables are extended with not more than 50 feet of 5/C#12 cable, the splice boxes must not be installed in water.

3.3 CAVE FEATURE LED LIGHTING FIXTURE PSU INSTALLATION

- A. Cave feature power supply units shall be installed within a NEMA Type 6P/IP68 submersible non-metallic junction box mounted to concrete pavers set on the cave floor or mounted to concrete bridge abutments or retaining walls at the edges of walking trails as indicated on the Drawings. Power supply units shall not be fastened directly to the cave.
- B. PSU junction boxes shall be provided as follows:
 - 1. Type A PSUs: Stahlin Catalog No. PC1412 with BP1412FG fiberglass inner back panel.
 - 2. Type B PSUs: Stahlin Catalog No. PC1614 with BP1614FG fiberglass inner back panel.

PSU junction boxes shall be provided in accordance with Section 260533.13 – Boxes for Electrical Systems.

- C. Installation of the PSU to the inner back panel and installation of incoming power PVC jacketed Type MC power cable connector(s) and output lighting fixture cable gland fittings shall be done in a clean, dry and well lite location and not inside the cave.
- D. Output Cable Connections: Provide one (1) to four (4) (as required for Type A PSUs) and five (5) to eight (8) (as required for Type B PSUs) IP68 straight nylon cable gland fittings in each PSU enclosure; Kable Kontrol, SAB North America or approved equal
- E. Each PSU shall have a line side luminaire disconnect installed inside the PSU enclosure.
- F. Connections within each cave feature lighting fixture power supply unit shall be made using the electrical terminal connectors provided with the PSU.
- G. Take care in making wiring terminations so as not to drop wire trimmings, insulation or other debris into the PSU enclosure.
- H. Output Cable Connections: Provide one (1) or two (2) (as ordered) IP68 straight nylon cable gland fittings factory installed in each driver enclosure; Kable Kontrol, SAB North America or approved equal.
- I. PSU drying procedure:
 - 1. Equipment required:
 - a. Milwaukee 0884-20 M18 Compact Blower, or equal
 - b. Milwaukee 2688-20 M18 Compact Heat Gun, or equal
 - c. Milwaukee 2267-20 Infrared Temp Gun or equal
 - d. Portable light, at least 500 lumens, 4000K, min 80CRI

- 2. Complete the following procedure after the startup and commissioning of the cave feature lighting system has been completed in accordance with Article 3.5 of this Section:
 - a. Using the Milwaukee 0884-20 M18 Compact Blower, or equal, ensure there is no dust or foreign materials in the PSU. Be careful not to touch the electronic components in the PSU with the blower nozzle. Generally, this process should be conducted from a distance of 4-inches or so, using the smallest nozzle. Ensure the cover is clean and ready to fit.
 - b. The Milwaukee 2688-20 M18 Compact Heat Gun does not have temperature control. Care must be taken to ensure components in the PSU are not damaged. The

Milwaukee 2688-20 M18 Compact Heat Gun should never be closer to the PSU than 12 inches. Using the Milwaukee 2688-20 M18 Compact Heat Gun, or equal:

- i. While maintaining a minimum distance of 12 inches, move the heat gun back and forth across the open surface of the PSU.
 - ii. Check the temperature inside the box every 30 secs using the Milwaukee 2267-20 Infrared Temp Gun or equal.
 - iii. When the temperature generally reaches 100°F stop heating.
 - iv. Allow to cool for 10 minutes.
- c. Reapply heat as per Item 2.b.i. above for 20 seconds.
 - d. After drying procedure has been completed, place an indicating silica gel, moisture absorbing, reusable desiccant canister, as specified herein, inside the PSU enclosure.
 - e. Fit the cover, secure the cover latches and tighten the four stainless steel cover screws as per the PSU enclosure manufacturer's instructions.
 - f. Cover screws shall be tightened to the torque value specified by the enclosure manufacturer.
 - g. Physically inspect and ensure the visible gap around the sealing surfaces is even.

3.4 CAVE GUARDRAIL LED LINEAR LIGHTING FIXTURE INSTALLATION

- A. Cave guardrail LED linear lighting fixtures must be ordered to the correct length using the manufacturer's order sheet. Lighting fixture segments cannot be cut to fit in the field.
- B. Install lighting fixtures, drivers, and all lighting fixture accessories in strict accordance with the lighting fixture manufacturer's instructions and as indicated on the Drawings.
- C. Installation of incoming power PVC jacketed Type MC power cable connector(s) shall be done in a clean, dry and well lite location and not inside the cave.
- D. *Pre-Installation Conference*: Provide a minimum of 6 hours of on-site instruction by an authorized field service representative of the cave guardrail LED linear lighting fixture manufacturer after the lighting equipment is delivered to the project site but before installation has begun to train the Contractor's installation personnel on the proper handling, installation and connection of the lighting fixtures and drivers.
- E. Cave guardrail LED linear lighting fixtures shall be installed on the horizontal stainless-steel mid-rail tube of the guardrails using the lighting fixture manufacturer's standard PVC mounting channel or stainless-steel spine channel (where required due to tight bends in the guardrail tube) with manufacturer provided Type 304 stainless steel Type H conduit clamps for securing the lighting fixture/mounting channel assembly to the guardrail tube. Linear lighting fixtures shall be installed to guardrails between vertical posts with factory jumpers between the fixtures around the back side of the post with serially connected fixtures and jumpers up to the maximum serially connected lighting fixture length allowed by the manufacturer. Secure the jumper to the back side of the vertical post using black nylon zip ties. Trim excess tail of zip tie with the proper tool to ensure there is not a sharp edge.
- F. Mount the LED linear lighting fixture on the guardrail in accordance with the detail on the Drawings and in accordance with the manufacturer's installation instructions with the fixtures positioned on the guardrail horizontal tube as required for the center of the beam to fall on the center of the walking trail.

- G. Mount the LED linear lighting fixture driver NEMA Type 6P/IP68 submersible enclosure to a vertical guardrail post in accordance with the detail on the Drawings.
- H. Each driver shall have a luminaire disconnect installed inside the junction box on the line side of the driver as well as an indicating silica gel, moisture absorbing desiccant canisters as specified herein.
- I. Connections within each guardrail LED linear lighting fixture driver enclosure shall be made using 3M Performance Plus twist-on, spring-type connectors with 3M No. 3570 epoxy resin sealing packs in accordance with Section 260583 – Wiring Connections.

3.5 FIELD STARTUP AND COMMISSIONING

- A. The Owner’s Cave Lighting Designer shall work with the Park Naturalist during a 5 to 10 consecutive workday period prior to substantial completion of the project to determine the final mounting location and proper aiming of each cave feature lighting fixture. The Contractor shall provide periodic support during this period for making adjustments to the lighting fixture locations and aiming as required.
- B. The cave feature LED lighting fixture manufacturer shall provide a factory authorized field services technician to provide startup and commissioning of the cave feature lighting system in conjunction with the work specified in Paragraph 3.5 A. Include (4) consecutive 8-hour days on site and all transportation and subsistence costs to perform the following services:
 - 1. Inspect installation for compliance with cave feature lighting fixture manufacturer’s requirements.
 - 2. Program each PSU for the required light output for each lighting fixture as directed by the Owner’s Cave Lighting Designer.
 - 3. Verify proper operation of all cave feature lighting equipment and confirm that the factory warranty is in effect.

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures, inoperable power supply units, drivers, and components.
- B. Test all lighting fixtures in the presence of the Construction Representative for proper operation.
- C. Malfunctioning Fixtures and Components: Repair or replace and retest. Repeat procedure until all units operate properly.

3.7 CLEANING AND ADJUSTING

- A. Fixtures shall be properly protected from damage or marring during construction until final acceptance by the Construction Representative.
- B. Fixtures, lenses, and enclosures shall be cleaned using methods and materials recommended by the fixture manufacturers and all fixtures, power supply units and drivers shall be in working order prior to final acceptance by the Construction Representative.

END OF SECTION 265613

SECTION 270500 – COMMON WORK RESULTS FOR COMMUNICATIONS

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 27 – Communications.

1.3 COORDINATION

- A. It is the intent of the Communications Division of these Specifications that all communications 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 communications system. Route cables 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.

1.4 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. Natural Resource: Onondaga Cave
- D. 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.
- E. 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.
- F. 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.

1.5 SUBMITTALS

- A. The Contractor shall submit to the Engineer 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 operating instructions and maintenance manuals in accordance with Section 013300 – Submittals, Section 007213 – General Conditions and 007300 – Supplementary Conditions.

1.6 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 Construction Representative.

1.7 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.	ANSI	American National Standards Institute
2.	ASA	American Standards Association
3.	ASTM	American Society for Testing & Materials
4.	BICSI	Building Industry Consulting Services International, Inc.
5.	BOCA	Building Officials and Code Administrators International, Inc.
6.	CSA	Canadian Standards Association
7.	EIA	Electronics Industries Association
8.	ETL	Electrical Testing Laboratories, Inc.
9.	FCC	Federal Communications Commission
10.	FS	Federal Specifications
11.	IBC	International Building Code
12.	IBEW	International Brotherhood of Electrical Workers
13.	ICC	International Code Council
14.	ICEA	Insulated Cable Engineers Association
15.	IEC	International Electrotechnical Commission
16.	IEEE	Institute of Electrical and Electronics Engineers
17.	ISO	International Standards Organization
18.	NEC	National Electrical Code (NFPA 70)
19.	NECA	National Electrical Contractors Association
20.	NEMA	National Electrical Manufacturers Association
21.	NFPA	National Fire Protection Association
22.	NIST	National Institute of Standards and Technology (formerly National Bureau of Standards, NBS)
23.	NTSC	National Television Standards
24.	OSHA	Occupational Safety and Health Administration
25.	TIA	Telecommunications Industry Association
26.	UL	Underwriters' Laboratories, Inc.

- D. Work installed shall be in strict compliance with governing codes and regulations. Installation shall be in accordance with installation recommendations and details provided by product manufacturers unless exceeded in quality by these specifications.

1.8 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 communications 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 2020 edition of the National Electrical Code (NEC) NFPA-70.
- C. The Contractor shall keep a copy of the 2020 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.

1.9 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 damage the natural resource. Coordinate work to avoid any negative impact to the natural resource.
- C. Drawings are based on equipment specified. Make adjustments, modifications, or changes required, due to use of other equipment.

1.10 WORKMANSHIP

- A. All work shall be done under the supervision of the Contractor who shall provide competent foremen to lay out all work. The Contractor shall immediately report to the Construction 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.

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 communications 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.

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 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.

2.4 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 communications work as shown on the Drawings and described in these Specifications.
- B. The work under Divisions 27 of the Specifications includes, but is not limited to, the following items:

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

X2212-01

1. Demolition of existing communications cables, raceways, boxes, equipment and equipment supports
2. Disconnection, handling, relocation and/or reconnection of existing communications equipment and cables as required and as shown on the Drawings
3. Removal and disposal off site of the existing equipment and materials to be removed
4. All communications systems wiring and raceways
5. Grounding and bonding
6. Emergency telephones

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 Construction Representative.
- B. The Contractor shall be responsible for protecting all communications 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 Construction Representative.

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 Construction 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 exact location of all communications 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 Construction 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 (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 location of all items shall be obtained from the Drawings. The Construction 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 COMMUNICATIONS WORK DEMOLITION AND RELOCATION OF EXISTING EQUIPMENT

- A. See Section 024119 – Selective Demolition and Section 270505 – Selective Demolition for Communications in these Specifications.

3.6 MOUNTING HEIGHTS

- A. Unless otherwise indicated elsewhere in these Specifications or Drawings, mounting heights of communications equipment shall be in accordance with the following schedule.
- B. The following item mounting heights shall be above finish floor/work platform to the horizontal centerline of the item.

<u>Item</u>	<u>Mounting Height</u>
1. Emergency telephones in the cave	4 feet 6 inches

3.7 FASTENING TO STRUCTURES INSIDE THE CAVE

- A. The methods of attaching or fastening equipment, equipment supports, raceways, or hangers to structures, such as the walking trail guardrail system inside the cave shall be subject to approval by the Construction Representative at all times.
- B. Support of communications equipment and raceways shall be provided in accordance with Section 270529 – Hangers and Supports for Communications Equipment.

3.8 COMMUNICATIONS 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 Construction Representative and/or Designer, the following:
 - 1. That all communications circuits are continuous and free from short circuits and unspecified grounds.

2. That all communication circuits are properly connected to the correct terminals of the communications equipment at each end of the cable.
 3. That all communications circuits and equipment function properly. Demonstration shall include the proper functioning and operation of each unit to the Owner's satisfaction.
 4. That all equipment requiring calibration and adjustment has been properly calibrated and adjusted in accordance with its intended function and the manufacturer's recommendations.
- B. All tests shall be made after notification to and in the presence of the Construction Representative and/or Designer and the authorities having jurisdiction, if required.
- C. The cost of labor, materials, instruments and supplies of any kind required for testing shall be borne by the Contractor.
- D. 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 Construction Representative at no cost to the Owner.

3.9 START UP

- A. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Construction 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 placed into service.
- C. The Contractor shall instruct the Owner's operating personnel in the operation and maintenance of the communications equipment during startup but prior to acceptance by the Owner.

END OF SECTION 270500

SECTION 270505 – SELECTIVE DEMOLITION FOR COMMUNICATIONS

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

1.3 RELATED SECTIONS

- A. Section 024119 – Selective Demolition
- B. Section 270500 – Common Work Results for Communications

1.4 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.

1.5 SUBMITTALS

- A. Schedule of Selective Communications Demolition Activities: Indicate detailed sequence of selective communications 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 communications 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.

1.6 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 communications demolition scope, procedures, schedule and items to be salvaged for the Owner.

1.7 PROJECT CONDITIONS

- A. Owner will occupy building during construction. Localized areas to be demolished will be vacated during demolition work. Conduct selective communications 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. Hazardous Materials: Hazardous materials may be present in the interior of the building to be selectively demolished.
1. If materials suspected of containing hazardous materials are encountered, do not disturb: immediately notify Designer and Construction Representative.
 2. Hazardous material remediation will be completed as a portion of this contract. This work is anticipated to be sequenced with the proposed phasing of construction activities.
- E. On-site storage or sale of removed items or materials is not permitted.
- F. Utility Service: Maintain communications service to building during selective communications demolition operations.

1.8 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.

1.9 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.

1.10 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 communications 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 communications circuitry or equipment to allow for structural demolition or removal of equipment.
- D. Review areas where existing communications 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 communications demolition operations.
- B. Survey existing conditions and coordinate and identify the extent of the communications 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 communications demolition work shall be performed without prior approval of the Construction Representative.
- B. Communications demolition work shall be carried on in a manner so as not to interfere with operation of the Owner's facilities.
- C. Any communications 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 communications service to occupied facilities except when authorized in writing by the Construction Representative.
- F. Provide temporary communications service during interruptions to existing communications systems, as acceptable to the Construction Representative.
- G. Unless noted otherwise, provide not less than two weeks notice to the Construction Representative if shutdown of communications 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 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 communications 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 communications demolition operations.
- B. Provide dust control and ventilation as required in areas of communications demolition.
- C. Execute communications 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 communications demolition.
- D. Provide temporary handrail, barricades, floor plates, etc. as required to provide protection for open elevated platforms, holes, etc. created by the communications 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.

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 communications 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 communications demolition work unless otherwise directed by the Construction Representative.

3.6 COMMUNICATIONS DEMOLITION - GENERAL

- A. Remove all work indicated on the Drawings and as required to complete the new work indicated.
- B. During communications demolition operations, keep areas adjacent to communications demolition work free of dust and debris.
- C. During communications demolition operations, if suspected hazardous materials or conditions are uncovered, stop work in that area, and inform the Construction Representative.
- D. Use cutting methods least likely to damage construction to remain or adjoining construction.
- E. 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.
- F. The use of cutting torches is prohibited.
- G. No power tool may be used that emits excessive noise or any type of gas or fumes.
- H. Electric or battery powered tools only. Any exception must be approved by the Park Superintendent.
- I. Locate selective communications demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- J. Dispose of demolished items and materials promptly.

3.7 COMMUNICATIONS DEMOLITION

- A. Protect existing communications 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 communications systems and shall inform himself of the status (active, inactive) of all communications systems to be demolished prior to proceeding.
- C. Prior to breaking or cutting communications cables 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 and cables as specified or as shown on the Drawings and as may become necessary because of existing field conditions at no additional cost to Owner.

3.8 EXISTING ITEMS TO REMAIN

- A. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective communications demolition.
- B. When permitted by Construction Representative, items may be removed to a suitable, protected storage location during selective communications demolition and reinstalled in their original locations after selective communications demolition operations are complete.

3.9 DISPOSAL

- A. All debris resulting from communications 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 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.

3.10 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective communications demolition operations.
- B. Return adjacent areas to condition existing before selective communications demolition operations began.

3.11 HAZARDOUS MATERIALS

- A. The Owner, to the best of his knowledge, has identified hazardous materials such as friable asbestos or lead in the work areas.
- B. Should the Contractor discover additional 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 270505

SECTION 270526 – GROUNDING AND BONDING FOR COMMUNICATION 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 270500 – Common Work Results for Communications
- B. Section 270553 – Identification for Communications System

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for the following items:
 - 1. Grounding conductors
 - 2. Grounding clamps
 - 3. Grounding connectors

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. All grounding conductors shall be insulated, stranded copper.
- B. Aluminum shall not be substituted for copper in grounding conductors.

2.2 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. Use products by Burndy Corp., O-Z/Gedney, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. The entire communications system and all communications 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 communications system.

- C. Insulated grounding conductors shall be identified with green colored insulation.
- D. All communications equipment shall be properly grounded.
- E. Connections: All grounding conductor connections shall be made in accordance with the manufacturer's written instructions. Chemically degrease and dry completely before 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 Engineer or Construction Representative.
- F. Grounding conductors and bonding jumper connection devices or fittings that depend on solder shall not be used.
- G. Equipment grounds shall be made where indicated on the Drawings. Total resistance to ground shall not exceed five (5) ohms.

END OF SECTION 270526

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS 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 communications equipment as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

- A. Section 270500 – Common Work Results for Communications
- B. Section 270533.13 – Conduit for Communications Systems
- C. Section 273213 – Industrial Telephone Sets

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for U-channel steel supports including associated hardware and accessories.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide materials, sizes, and types of supports, anchors, and fasteners to carry the loads of communications equipment. Include weight of raceway and cable when selecting products for communications equipment supports.

2.2 ANCHORS AND FASTENERS

- A. Provide anchors and fasteners as required to install all communications equipment raceways, cable, enclosures and equipment.
- B. Provide adequate corrosion resistance for all fastening systems.
- C. Bolts and Nuts: ANSI regular series, semi-finished, hexagon, Type 304 or Type 316 stainless steel
- D. Flat Washers: Type 304 or Type 316 stainless steel
- E. Lock Washers: ANSI medium, spring type, Type 304 or Type 316 stainless steel
- F. U-Bolts: Type 304 or Type 316 stainless

- G. Beam Clamps: Beam and angle clamps by B-Line, Thompson or Thomas & Betts, Type 304 or Type 316 stainless steel

2.3 STRUCTURAL SUPPORT SYSTEMS

- A. Steel Supports: Brackets, frames and hangers shall be fabricated from Type 304 or Type 316 stainless steel structural steel shapes or prefabricated structural systems, as manufactured by B-Line Systems, Inc., Unistrut Corporation, Kindorf Electrical Products Co., or approved equal.
- B. Prefabricated structural steel supports shall be 12-gauge, 1-5/8" x 1-5/8".
- C. Hanger Supports: Threaded rods, Type 304 or Type 316 stainless steel

PART 3 - EXECUTION

3.1 GENERAL

- A. The methods of attaching or fastening equipment or equipment supports or hangers to structures inside the cave, such as the walking trail guardrail system, shall be subject to the approval of the Construction Representative.
- B. Do not drill or cut any structural steel members or guardrails.
- C. Do not cut any structural concrete members.
- D. Welding is not permitted on any structure.
- E. Do not use piping, raceways, or equipment as structural members for support.
- F. A minimum of four (4) anchor points shall be provided for electrical communications equipment enclosures.

3.2 ANCHORS AND FASTENERS

- A. Nails shall not be used as a means of fastening.
- B. Do not use spring steel clips.
- C. Do not use powder-actuated anchors.

3.3 STRUCTURAL SUPPORT SYSTEMS

- A. Welding is not permitted. Provide bolted connections using structural member manufacturer's standard fittings and accessories.
- B. Do not use chain.
- C. Do not use perforated strap or wire.

END OF SECTION 270529

SECTION 270533.13 – CONDUITS FOR COMMUNICATIONS 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 270500 – Common Work Results for Communications
- B. Section 270526 – Grounding and Bonding for Communications Systems
- C. Section 270529 – Hangers and Supports for Communications Equipment
- D. Section 270553 – Identification for Communications Systems

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for the following items:
 - 1. Rigid non-metallic conduit and fittings
 - 2. Conduit mounting clamps

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 for communications systems shall be 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.
 - 1. Minimum conduit size shall be 1-inch.
 - 2. Rigid non-metallic conduit (PVC) shall be used inside the cave (on cave side of air lock doors).
 - 3. Adhesive for PVC conduit shall be as recommended by the manufacturer of the PVC conduit

2.2 CONDUIT MOUNTING CLAMPS

- A. Conduit mounting clamps for mounting conduits to channel supports shall be Type 304 or Type 316 stainless steel to match channel support material, B-Line B2000 Series or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. CONDUIT

1. Verify routing and termination locations of conduits at emergency telephone enclosures prior to rough-in.
2. Conduit connection to emergency telephone enclosures shown in the emergency telephone mounting detail on the Drawings is approximate. Terminate conduit in the bottom of the enclosures in accordance with the telephone manufacturer's instructions.
3. Coordinate conduit routing at guardrails with the Construction Representative.
4. Conduit or fittings having any type of defects shall not be used in the work.
5. Utilize U-channel supports and associated fittings and hardware for conduit support in accordance with Section 260529 – Hangers and Supports for Electrical Equipment.

B. CONDUIT MOUNTING CLAMPS

1. Only Type 304 or Type 316 stainless steel U-channel support conduit clamps shall be used inside the cave.

END OF SECTION 270533.13

SECTION 270553 – IDENTIFICATION FOR COMMUNICATIONS 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 communications identification for communications equipment and cables as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

- A. Section 270500 – Common Work Results for Communications
- B. Section 270526 – Grounding and Bonding for Communications Systems
- C. Section 271513.13 – Communications Copper Direct Buried Cabling

1.4 SUBMITTALS

- A. Submit electrical identification data as follows:
 - 1. Nameplate type product data
 - 2. Nameplate engraving schedule
 - 3. Cable identification label product data

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplates shall be three-layer laminated plastic with engraved black characters on a white background.
- B. Nameplate engraving shall be as follows:
 - 1. Lettering font shall be Gothic.
 - 2. Nameplate character sizes shall be:
 - a. 1/2-inch high – Emergency telephone enclosures.
 - 3. Lettering shall be centered on nameplate.
 - 4. Nameplates shall have a maximum of twenty (20) characters per line with a maximum of four (4) lines.
 - 5. Wording on nameplate shall include the equipment designation as indicated on the Drawings:
 - a. MISSOURI CAVERNS
 - b. SLUMP PIT OVERLOOK
 - c. LOWER SLUMP PIT
 - d. QUEEN’S CANOPY

- e. LOWER KING'S CANOPY
OVERLOOK
- f. TWINS
- g. LOST RIVER

6. Engraving designations shall be approved by the Designer.

2.2 CABLE MARKERS

- A. Cable markers shall be polyester film, non-adhesive, plate type designed for cable tie banding parallel to the cable.
- B. Cable identification markers shall be printer generated.
- C. Character size for cable identification markers shall be a minimum of 1/8-inch high.
- D. Markers, printing method and attachment method shall be subject to the approval of the Designer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Degrease and clean surfaces to receive nameplates.

3.2 NAMEPLATES

- A. Nameplates shall be provided for each emergency telephone enclosure.
- B. Nameplates shall be secured with an approved adhesive such as Goodyear "Pliobond" glue.

3.3 CABLE MARKERS

- A. All telecommunications cables shall be identified.
- B. Attach a cable identification marker to each cable at all termination points.
- C. Cable markers shall identify each cable with the circuit number.
- D. Cable markers shall be secured with heavy duty plastic cable ties. Cut excess tie material off flush with tie clasp. Do not leave sharp edges.

END OF SECTION 270553

SECTION 271513.13 – COMMUNICATIONS COPPER DIRECT BURIED CABLING

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 communications direct buried copper cabling as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

- A. Section 270500 – Common Work Results for Communication
- B. Section 270526 – Grounding and Bonding for Communications Systems
- C. Section 270533.13 – Conduit for Communications Systems
- D. Section 270553 – Identification for Communications Systems

1.4 SUBMITTALS

- A. Manufacturer's product data sheets shall be submitted for copper direct buried cable.
- B. Submit test report indicating results for copper cable continuity and resistance testing.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All cable shall have copper conductors; aluminum shall not be substituted nor permitted.
- B. All cable shall be new 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 conductor sizes are expressed in American Wire Gauge (AWG). Unless otherwise indicated, all conductors shall have 80°C rated insulation (wet or dry).
- D. Cables shall be provided in accordance with the requirements of ICEA S-86-634.

2.2 COPPER DIRECT BURIED CABLE

- A. All cable for telecommunications, installed inside the cave, shall be copper direct buried distribution cable.
 - 1. Conductors: Solid annealed bare copper, 22 AWG
 - 2. Insulation: Weather resistant, high density polyethylene (HDPE) color-coded per ICEA S-86-634.
 - 3. Pairing: Varying twisted pair lays to limit crosstalk

4. Core Filler: 80°C filling and flooding waterproofing compounds
5. Armor: Polymer-coated corrugated galvanized steel or stainless steel
6. Jacket: Black, linear low-density polyethylene or polyvinyl chloride (PVC), thickness per ICEA S-86-634, with rip cord for easy access to pairs
7. Testing: All cables shall be tested in accordance with the applicable requirements of ICEA S-86-634
8. Identification: Surface printing on the cable jacket shall be per ICEA S-86-634 requirements.
9. Manufacturer: Custom Cable Corporation, General Cable Company, Omni Cable or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Store all cable indoors, protected from moisture.
- B. Cables shall be continuous from source to destination without splices or taps.
- C. Install cable with adequate bending radius in accordance with the cable manufacturer's recommendations and ICEA S-86-634, but not less than eight (8) times the cable outside diameter.
- D. All cable shall be installed directly from reels or coils. Cables shall not be pulled along the cave floor or subjected to treatment that may cause abrasion or other damage to cable jacket.
- E. Cable shall be installed as recommended by the manufacturer.
- F. Cables shall be routed on the surface of the cave floor next to the walking trail as indicated on the Drawings. Do not disturb the cave by trenching the floor or cutting through rock. Verify routing of cables with the Construction Representative and Park Naturalist before proceeding with the installation. Push cables into the mud for entry into 1" PVC conduit at emergency telephone connections.

3.2 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 signoffs
 - d. Completed data sheets
 - e. Test log and observations
 - f. Certificate of Compliance
- B. Inspect each cable for physical damage and proper connection.
- C. Torque test conductor connections and terminations to manufacturer's recommended values.
- D. Perform continuity tests.

END OF SECTION 271513.13

Upgrade Cave Electric
Onondaga Cave State Park, Leasburg, Missouri

X2212-01

COMMUNICATIONS COPPER DIRECT BURIED CABLING

271513.13 - 3

SECTION 273213 – INDUSTRIAL TELEPHONE SETS

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 industrial telephone sets as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

- A. Section 270500 – Common Work Results for Communications
- B. Section 270526 – Grounding and Bonding for Communications Systems
- C. Section 270529 – Hangers and Supports for Communications Equipment
- D. Section 270533.13 – Conduit for Communications Systems
- E. Section 270553 – Identification for Communications Systems
- F. Section 271513.13 – Communications Copper Direct Buried Cabling

1.4 SUBMITTALS

- A. Manufacturer's product data sheets and installation instructions shall be submitted for industrial telephone sets.

1.5 LISTING REQUIREMENTS

- A. Industrial telephone sets shall bear the UL Mark and shall be listed to the most recent edition of UL/CSA 60950.

1.6 QUALITY ASSURANCE

- A. All industrial telephone sets 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 EMERGENCY TELEPHONES FOR USE INSIDE THE CAVE

- A. Industrial telephone sets are to be provided for use as emergency telephones inside the cave.
 - 1. Non-metallic, corrosion-proof red enclosure
 - a. NEMA 4X rated with door closed and latched.
 - b. NEMA 3R rated with door open

2. Line-powered, analog operation
3. Heavy-duty handset with noise-cancelling microphone, hearing aid compatible receiver and Hytrel® coiled cord (6-foot extended)
4. Brushed stainless steel front panel with push-button volume control
5. Chrome-plated metal keypad with protective rubber boot
6. Magnetic reed, non-movable hookswitch
7. Integral ringer, 85 dB SPL
8. Stainless steel security mounting screws (Provide Torx T-25, 1/4" drive tip with each telephone)
9. Stainless steel assembly hardware
10. Conformal-coated printed circuit board
11. Off-hook detect contact closure output

B. Electrical Specifications:

1. Frequency Response: 300 to 3,000 Hz
2. Inter-Digit Pause: 100ms
3. Minimum Loop Current: 20mA
4. Operation: Loop Start
5. Signaling Tone (DTMF): 100ms Tone Duration
6. Supervisory DC Current: 20mADC minimum, 60mADC maximum
7. Supervisory DC Voltage: 24VDC to 60VDC (not polarity sensitive)
8. Network Interface: Loop Start
9. Minimum Loop Center: 20mA
10. Network Signaling: DTMF
11. Off-Hook Detect Output Rating: 48VDC @ 125mA
12. Ringer Audio Level: 85dB SPL @ 1foot on axis

C. Environmental Specifications:

1. Operating Temperature: -40°C to +60°C operating temperature range
2. Humidity: 90% non-condensing
3. Enclosures for Electrical Equipment: UL 50 Type 4X with door closed and latched

D. FCC Information:

1. Must have FCC registration number
2. Ringer Equivalence Number (REN): 1.0A/1.3B
3. Network Connection (USOC): RJ11

E. Mechanical Specifications:

1. Enclosure Material: Engineered Plastic or Fiberglass
2. Handset Cord: "G" style handset/ Hytrel® coiled cord (6-foot extended)
3. Connections: Screw terminals
4. Mounting: Four (4) external mounting feet

F. Lightning Arrester:

1. Provide UL listed and labeled lightning arrester in accordance with the telephone set manufacturer's requirements.

2.2 APPROVED MANUFACTURERS

- A. Subject to compliance with all requirements specified herein, provide products by one of the following:
 - 1. GAI-TRONICS
 - 2. CEECO
 - 3. KNTECH
- B. The design of the emergency telephone system installation has been based on the GAI-Tronics Model 354-001 Series industrial telephone set. Should the Contractor choose to provide equipment from one of the approved equal manufacturers, he will be responsible for any additional costs resulting from physical changes and/or required accessories

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 industrial telephone sets in accordance with the manufacturers written instructions.
- C. Provide Schedule 40 PVC conduit connection to bottom of the telephone set enclosure using a UL listed NEMA 4X rated connector or a stainless-steel threaded conduit hub. Conduit hubs shall be provided in accordance with Section 260533.13 - Conduit for Electrical Systems. Seal all conduit entrances around the entry point and inside the conduit using an approved silicone type sealant that is compatible with the telephone cable jacket material.
- D. Open enclosure door, remove front panel assembly, provide conduit opening in bottom of the enclosure using a properly sized punch or hole saw and install conduit hub or fitting.
- E. Connect cable conductors and test telephone set in accordance with the manufacturer's instructions.

3.2 IDENTIFICATION

- A. Each emergency telephone enclosure shall have a laminated plastic nameplate, with engraved black characters on a white background, on the outside surface of the door engraved with the designation as indicated on the Drawings in accordance with Section 260553 - Identification for Electrical Systems.

END OF SECTION 273213

SECTION 310000 – EARTHWORK

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. This Section includes the following:
 - 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 include the following:
 - 1. Section 311000 – Site Clearing
 - 2. 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: Course 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 Construction 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 Construction Representative. Unauthorized excavation, as well as remedial work directed by Construction 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. 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 3/4 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.
- M. 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.
- N. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement.

- O. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- P. 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.
- Q. 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. 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 Designer.
- C. Field Quality Control test reports and logs.
- D. 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 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Construction Representative and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Construction Representative not less than two weeks in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Representative's written permission.

3. Contact utility-locator service for area where Project is located before excavating.
- B. 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.

1.6 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. 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. 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 Construction Representative.
- C. 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. 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:

<u>Sieve Size</u>	<u>Percent Passing</u>
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.

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/ft²; 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 1×10^{-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. 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.

B. 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 contact the Construction Representative at the beginning of each phase to arrange for utility locates in the construction area.
- C. Time spent by Owner to identify utilities and status of utilities discovered during excavation and not shown on the Drawings shall not be the basis of a change order request from the Contractor.

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 earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 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.

3.4 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.5 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 Construction 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 Construction 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.

3.6 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.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.8 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
- C. 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.

3.9 SUBGRADE INSPECTION

- A. Notify Contractor's geotechnical engineer and Construction Representative when excavations have reached required subgrade.
- B. If geotechnical engineer determines that unsuitable soil is present, advise Construction Representative. After receiving approval of Construction 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 Construction 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.

3.10 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 Construction Representative.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by geotechnical engineer, subject to approval of Construction Representative.

3.11 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 suitable 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. Do not store within drip line of remaining trees.
 - 2. Stockpile soil materials only in designated areas approved by the Construction Representative.

3.12 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 Construction 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 topsoil. Soil backfill shall be subject to approval of Construction Representative.

3.13 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.

3.14 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 33 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. Coordinate backfilling with utilities testing.
- F. Backfill voids with suitable soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of suitable 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.

3.15 SOIL FILL

- A. Plow, 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.

3.16 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 suitable soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.17 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.

3.18 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.

3.19 SEEDING/SODDING

- A. Furnish and install seeding and sodding.

3.20 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 Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
 - 2. Pavements: Plus or minus 1/2 inch (13 mm).

3.21 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.

3.22 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 Construction Representative; 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.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil and waste material, including unsuitable soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 310000

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. This Section includes the following:
 - 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 include the following:
 - 1. Division 31 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. 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 or other materials indicated to remain on 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, which identify and accurately locate 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 requirements of Division 1 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 authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Construction Representative.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earthwork."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.
- B. Granular Backfill: Requirements for granular backfill materials are specified in Division 31 Section "Earthwork"
- C. Controlled Low Strength Materials: Requirements for Controlled Low Strength Materials (CLSM) are specified in Division 31 Section "Earthwork".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Stake site clearing limits and obtain approval of Construction 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.
- B. Provide erosion, sedimentation, and water pollution control measures at all locations where drainage is leaving the site.
- C. Comply with EPA and Missouri DNR rules and regulations and Best Management Procedures for Storm Water Pollution Prevention.
- D. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

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 Construction Representative not less than two weeks in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Construction 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. Topsoil will not be stripped and stockpiled separate from subsoil.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- 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.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

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 310000 – Earthwork
 - 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 Construction Representative no fewer than two weeks in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Construction 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 Construction 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 Construction 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 Construction 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 Construction 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 Construction Representative.
 - 2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earthwork."

3. Repair or replace, as approved by Construction Representative, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

SECTION 321413 – PRECAST CONCRETE UNIT PAVERS

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 Precast Concrete Unit Pavers as specified herein and as shown on the Drawings.

1.3 RELATED SECTIONS

- A. Section 265613 - Cave Lighting Fixtures, Power Supply Units and Drivers

1.4 SPECIFICATIONS AND STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates
 - 2. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
 - 3. ASTM C150 - Standard Specification for Portland Cement
 - 4. ASTM C936 - Standard Specification for Concrete Interlocking Paving Units

1.5 SUBMITTALS

- A. Submit manufacturer's product data sheets for each type of precast concrete unit paver.
- B. Submit test results from an independent testing laboratory for compliance with performance requirements specified herein.
- C. Submit two complete sets of color chips representing paver manufacturer's full range of available colors. Color will be selected by Owner from manufacturer's available standard colors.
- D. Samples: Provide one sample paver of each size/type in the color selected by the Owner from the submitted color chips.

1.6 QUALITY ASSURANCE

- A. Manufacturer of products specified under this Section shall have a minimum of ten (10) years proven production experience.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Precast concrete unit pavers shall be stretch wrapped in rows and banded on pallets and delivered in original unopened packaging with legible manufacturer identification, including size, quantity, and manufacture date.
- B. Protect precast concrete unit pavers during shipment, storage and construction against damage. Store a minimum of 4 inches off the ground on pallets in a dry location above 40°F and cover

with polyethylene to protect from contact with materials which would cause staining or discoloration.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE UNIT PAVERS

- A. Compressive Strength: The average compressive strength at time of delivery shall not be less than 8,000psi with no single unit less than 7,000psi per ASTM C140.
- B. Water Absorption: The average water absorption shall not be greater than 5% per ASTM C936.
- C. Density: Concrete density shall be greater than 130 lb/cubic foot.
- D. Size and Thickness: Provide in manufacturer's standard or custom sizes as indicated on the Drawings. Paver size shall not differ by more than 1/16 inch (1.6 mm) from width, height, length or thickness. Units shall conform to a true plane and not differ by more than 1/16 inch (1.6 mm) in either concave and/or convex warpage.
- E. Edge Finish: Provide 3/16" bevel or radiused top edge on all four (4) sides.
- F. Color: Provide in manufacturer's standard color as selected by Owner from color chips representing the paver manufacturer's full range of available colors. Only inorganic compounds shall be used for coloring the concrete.

2.2 APPROVED MANUFACTURERS

- A. Precast concrete unit pavers shall be as manufactured by:
 - 1. Romanstone Hardscapes Century or Classic Series; Chatham Paver, Holland Stone or Ledge Rock
 - 2. Or approved equals by Abbotsford Concrete Products, CST Hardscapes or Tile Tech Pavers, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Precast concrete unit pavers are to be used for installation of cave feature lighting fixtures and power supply units in accordance with Section 265613 - Cave Lighting System and the associated mounting details on the Drawings.

END OF SECTION 321413

SECTION 329219 - SEEDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. This part of the Specification includes all labor, materials, equipment and supervision required for Seeding.
 - 2. This section includes the specifications for seedbed preparation; fertilization; seeding; and mulching.

1.2 SUBMITTALS

- A. Manufacturers or vendor's certified analysis of fertilizer.
- B. Seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentages by weight, and percentages of purity, germination, and weed seed for each grass seed species.
- C. Planting Schedule: Proposed seeding schedule, indicating dates for seeding work during normal seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- D. Normal seasons for this work are as follows:
 - 1. Spring: March 1 - May 31.
 - 2. Fall: August 10 - September 30.
- E. Furnish detailed written recommended maintenance program to the Owner with a copy to the Owner's Representative, prior to final inspection of the seeding.

1.3 QUALITY ASSURANCE

- A. Subcontract seeding to a single firm specializing in seeding as specified.
- B. Source Quality Control:
 - 1. Ship seeding materials with certificates of inspection required by governing authorities.
 - 2. Comply with regulations applicable to seeding materials.
 - 3. Do not make substitutions. If specified material is not obtainable, submit proof of non-availability to Owner's Representative, together with proposal for use of equivalent material.
 - 4. Analysis and Standards: Package standard products with manufacturers certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. If seed is mixed prior to delivery on site, it shall be tagged showing a guaranteed statement of composition of mixture and percentage of purity and germination of each variety.
- B. If seed is to be mixed at the site, it shall be delivered in original containers bearing producers certification of germination and purity.
- C. Tags shall show producers or dealers Missouri Permit Number and date of testing; test date shall be no more than 90 days previous to time of use.
- D. Fertilizers shall conform to State of Missouri laws and regulations. If delivered in bulk, bills of lading or other labels shall be furnished to the Landscape Architect or labels indicating analysis and weight information from each container shall be preserved and furnished to the Owner's Representative within twenty-four (24) hours of application.
- E. Handling of materials as recommended by manufacturer.
- F. Store all packaged materials off ground and protect from moisture and rodents.
- G. Storage of all materials in locations designated and approved by Owner's Representative.

1.5 JOB CONDITIONS

- A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required.
- B. Grade Stakes: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.
- C. Protect existing irrigation system, structures, utilities, sidewalks, pavements, and other facilities during seeding operations. Repair any damage at no cost to the Owner.

1.6 SEQUENCING & SCHEDULING

- A. Planting Time: Proceed with, and complete seeding as rapidly as portions of site become available, working within seasonal limitations for each kind of seed required.
- B. Chronological procedure for seeding is to remove any existing vegetation, disc, fertilize, prepare the seedbed, seed, and then mulch.
- C. Schedule seeding work to occur as roadway work progresses. Identify areas ready for seeding and obtain approval of Landscape Architect to proceed. As areas of seeding are completed, proceed in accordance with Article 3.10 ACCEPTANCE AND WARRANTY.

1.7 SPECIAL PROJECT WARRANTY

- A. Warranty lawns to provide specified germination and seed emergence.

PART 2 - PRODUCTS

2.1 FERTILIZER

- A. Grade: Commercial grade conforming to current requirements of the Missouri Department of Agriculture, uniform in composition, liquid or dry and free flowing.
- B. Formulation: 8:32:16, or plant food ratio of 1:4:2.

2.2 SEEDING MATERIALS

- A. Grass Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America.
- B. Seed Mix: Commercial mix consisting of the following grass species:

Species	% of Mix by Weight	Germ
Turf-Type Tall Fescue	60%	90%
Tall Fescue	30%	90%
Perennial Ryegrass	10%	90%
TOTAL MIX	100%	90%

- C. Each seed mix bag shall bear supplier’s “blue tag” certification.

2.3 STRAW MULCH

- A. If Hydro seeding is not performed, provide clean, weed free threshed straw of wheat, rye, or oats. Straw harvested after killing frost or during dormant periods as well as discolored, weathered, rotted, brittle, moldy, or caked materials is unacceptable.
- B. Fifty percent (50%) of fiber of each straw bale shall be ten inches (10") or longer.

PART 3 - EXECUTION

3.1 EQUIPMENT

- A. Cultipacker: Use a pull-type cultipacker with individual rollers or wheels. The cultipacker must produce a corrugated surface on the area being compacted. Operate the cultipacker separately from all other operations, and do not attach the cultipacker to the seeder or disk, unless combined cultipacker seeder is manufactured for such us is utilized.
- B. Disk: When preparing a seedbed on ground having heavy vegetation, use a disk with cutaway blades. Use weights or other provisions to obtain proper cutting depth.
- C. Drop Seeder: Use one piece of equipment containing pulverizer rollers in front of the seed tubes, ground driven seed meters, maximum seed tube spacing of 3 inches delivering seed between the pulverizer rollers and packer wheels, and packer wheels that press and firmly pack seed into the soil.

- D. Endgate Cyclone Seeders: Endgate cyclone seeders must be suitably mounted. Movement must be provided by mechanical means. The seed drops through an adjustable flow regulator onto a rotating, power driven, horizontal disk or fan.
- E. Field Tiller: Tiller designed for the preparation of the seedbed as specified.
- F. Gravity Seeders: Gravity seeders must provide agitation of the seed, have an adjustable gate opening, and uniformly distribute seed on the prepared seedbed. Use a seed hopper equipped with baffle plates spaced no more than 2 feet apart. The baffle plates must extend from the agitator shaft to within approximately 2 inches of the top of the seed hopper. Wind guards are required to facilitate seeding when moderate wind conditions exist. Place wind guards in front or in back (or both) of the seed outlet and extend them to near the ground line.
- G. Hydraulic Seeder: Use hydraulic seeding equipment with a pump rated at no less than 100 gallons per minute. Inoculant, seed, and fertilizer may be applied in a single operation. The equipment must have a suitable working pressure and a nozzle adapted to the type of work. Supply tanks must have a means of agitation. Calibrate tanks and provide them with a calibration stick or other approved device to indicate the volume used or remaining in the tank.
- H. Mowers: Shall be rotary, flail, disk, or sickle type. Do not use mowers that bunch or windrow the mowed material.
- I. Mulch Anchoring Equipment: Equipment designed to anchor straw or hay mulch into soil by means of dull blades or disks. It shall have flat blades or disks, may have cutaway edges and must be spaced at approximately 8 inch intervals. The mulch anchoring equipment must be pulled by mechanical means and have sufficient weight to crimp the straw.
- J. Native Grass Seed Drill: Use a native grass seed drill designed to provide uniform distribution of native grass and wildflower seeds. Provide separate seed boxes to apply both small seeds as well as fluffy bearded seeds. If a no-till attachment is specified, use an attachment of the same manufacturer as the drill.
- K. Rotary Tiller: Equipment with rotary-type blades designed for the preparation of seedbed as specified.
- L. Slit Seeder: Use a gas, diesel or electric powered mechanical slit seeder that is capable of cutting vertical grooves a maximum of 1/4 inch deep into the soil with a maximum horizontal blade spacing of 3 inches, deposits metered seed directly after the formation of the vertical grooves, and contains packer wheels that press and firmly pack seed into the soil.
- M. Straw Mulching Machine: Use a machine to uniformly apply mulch material over the desired area without excessive pulverization. Excessive pulverization is the general absence of straw longer than 6 inches after distribution.

3.2 SEEDBED PREPARATION

- A. Limit preparation of seedbed to areas that will be seeded immediately upon completion.
- B. Work areas accessible to field equipment to a depth of no less than 3 inches. Use mechanical rotary tillage equipment for the preparation of seedbed on earth shoulders, urban or raised medians, and rest areas. Prepare by hand areas inaccessible to field machinery, to a depth of no less than 2 inches. Where weed growth has developed extensively, they may be disked into the

ground. If weed growth develops sufficiently to interfere with proper seedbed preparation, mow the weeds and remove them from the project at no additional cost to the Owner.

- C. Use crawler type or dual-wheeled tractors for seedbed preparation. Operate equipment in a manner to minimize displacement of soil and disturbance of the design grading. Harrow ridging in excess of 4 inches due to operation of tillage equipment prior to rolling with the cultipacker. Roll the area with no less than one pass of the cultipacker prior to seeding.
- D. Shape and fine grade to remove rills or gullies, water pockets, undesirable vegetation, and irregularities to provide a smooth, firm, and even surface true to grade and cross- section. Prepare to a fine texture and without soil lumps. Till parallel to the contours.
- E. Smooth the seedbed with a cultivator-type tillage tool having a rake bar or a rock rake. Pick up and remove all debris, such as rocks, stones, concrete larger than 2 inches (1/2 inch maximum for lawn seeding), or roots and other objectionable material that will interfere with the seeding operation. A spring tooth cultivator may be used in lieu of a rock picker. Remove the rock by hand after each use of the cultivator; repeat the process until the soil is relatively free of rock.
- F. Choose equipment to minimize soil compaction. Operate equipment in a manner to minimize displacement of soil and disturbance of the design grading. Roll the area with at least one pass of the cultipacker. Remove ruts that develop during the sequence of operations before subsequent operations are performed. This must be completed just prior to seeding.

3.3 FERTILIZATION

- A. A. Apply fertilizer immediately prior to seedbed preparation. Incorporate the fertilizer into the top 2 to 3 inches of topsoil during the seedbed preparation. Equipment that results in ruts or excessive compaction will not be allowed.
- B. Do not apply fertilizer with native grass, wildflower, or wetland seeding.

3.4 CONVENTIONAL SEEDING

- A. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
- B. Use methods and procedures consistent with equipment manufacturer's recommendations; however, do not operate ground-driven equipment at speeds greater than 10 mph.
- C. On all areas accessible to machinery, sow seed with a gravity seeder, endgate cyclone seeder, or seed drill. Each application of seed shall overlap the previous application by one-half (1/2) the application width to insure double coverage.
- D. On areas inaccessible to field machinery, the use of hand-operated cyclone seeders will be allowed, but no other hand-seeding methods will be accepted.
- E. All seeded areas will have one pass with a roller or cultipacker to firm the soil.
- F. Sow seed mix at the rate of 8-10 lbs. per 1000 sq. ft.

3.5 HYDRAULIC SEEDING

- A. Order of Operations:

1. Seedbed Preparation
 2. Seed application, fertilizing and mulching
 - 3.
- B. Seedbed Preparation: Follow seedbed preparation for conventional seeding.
- C. Seed Application, Fertilizing and Mulching:
1. Application Process:
 - a. Combination: Place all material, seed, fertilizer, mulch, and tackifier (if applicable) in hydraulic mulching equipment specifically manufactured for hydraulic seeding.
 - b. Separate: At the Contractor's option and at no additional cost to the Owner, the hydraulic seeding, fertilizing, and mulching may be undertaken separately. If operations are undertaken separately, complete fertilizing and mulching application within 24 hours of completing seeding work. Do not separate the applications if inclement weather is forecasted within 24 hours of the scheduled application period.
 2. Ensure the hydraulic equipment, pump, and application process do not damage or crack seeds.
 3. Mix materials with fresh potable water using a combination of both recirculation through the equipment's pump, and mechanical agitation to form a homogeneous slurry.
 4. Apply mixture within 1 hour after seed and fertilizer are placed in the hydraulic seeder.
 5. If necessary, dampen dry, dusty soil, to prevent balling of the material during application.
 6. Apply the slurry evenly over all specified areas at component material rates specified.
 - a. Wood Cellulose Mulch:
 - 1) Mulch: Minimum 3,000 lb./acre dry weight.
 - 2) Tackifier: Minimum 50 lb./acre.
 - b. Bonded Fiber Matrix: Minimum 3,000 lb./acre dry weight.
 - c. Mechanically bonded Fiber Matrix: Minimum 3,000 lb./acre dry weight.
 7. Provide documentation to ensure final application rate.

3.6 MULCHING

- A. Protect seeded areas against erosion by spreading specified mulch after completion of seeding operations.
- B. Spread uniformly to form a continuous blanket and apply at a rate of one and one half (1 1/2) tons per acre.
- C. Anchor mulch by crimping into the soil a minimum depth of two inches (2").
- D. Provide and install additional erosion control materials where shown on the drawings.

3.7 WATERING

- A. Provide water, equipment, transportation, water tanker, hoses, and sprinklers.

- B. Use enough water to keep the soil and mulch moist to a depth of 1 inch and ensure growth of the seed. For turfgrass seeding areas, sufficiently water to keep the soil moist for a minimum of 21 days. If natural rainfall is adequate to keep the soil and mulch moist, artificial watering may not be needed.

3.8 RE-SEEDING

- A. When all work related to seeding, fertilizing, and/or mulching has been completed on an area, and is washed out or damaged, re-seed, fertilize, and/or mulch the area as necessary at no additional cost to the Owner.
- B. The contractor shall be responsible for maintaining erosion control throughout construction.

3.9 CLEANUP AND PROTECTION

- A. All work related to cleanup throughout the project and upon completion is the responsibility of the Contractor, at no additional cost to the Owner.
- B. Restore to proposed grade, reseed, and remulch all eroded and/or washed out areas which develop prior to acceptance of seed.
- C. During seeding work, keep pavements clean and work area in an orderly condition. A.Remove all excess material
- D. Repair any damage resulting from seeding operations.
- E. Upon completion of job, clean-up all debris, caused by work, and excess material and leave area within contract limits in a neat and clean condition. Remove hydraulic slurry and other excess debris related to seeding operations from buildings, landscaping, mulch, pavement, signs, sign posts, and any other areas not specified for application, at the end of each day.

3.10 ACCEPTANCE AND WARRANTY

- A. Guarantee in writing that all work has been completed as specified and provide the date that all activities were completed. Upon completion of the work and fulfillment of the requirements of this Section, notify the Owner's Representative in writing that the work is ready for final inspection.
- B. Request a definite date for final inspection.
- C. Notify the Owner's Representative five (5) days prior to the requested final inspection date.
- D. Acceptance will occur, provided seeded areas are in a live, healthy, growing, and well-established condition without eroded areas, bare spots, weeds, undesirable grasses, disease, or insects. Any areas having less than 90% coverage will not be accepted.
- E. Projects will be accepted no sooner than 60 days from the date that all activities were completed.
- F. Reseed and maintain all seeded lawn areas which do not meet the requirements of this Section at the time of final inspection. Reseeded areas will be accepted no sooner than 60 days from the date that reseeded occurred.
- G. Replacement work shall be as specified for original seeding.

H. Replacement work shall be reinspected before acceptance.

END OF SECTION 329219