Fairfax Water

8570 EXECUTIVE PARK AVENUE
FAIRFAX, VIRGINIA 22031

Invitation for Bids NO. 24-214

PROJECT MANUAL FOR
Project 0215A, Division 041
RESTON PUMP STATION ELECTRICAL UPGRADES

August 2024

BID-SET



DOCUMENT 00001 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. General:

1. Christopher D. Mata
2. License # 0402058063
3. Responsible for Division 1



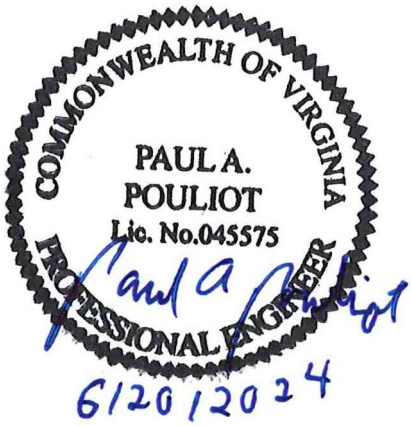
B. Architecture:

1. Steven Jay Bradford
2. License # 0401012635
3. Responsible for Sections 054000, 061600, 074213.19, 076200, 079100, 079200, 09069, 09967.



C. HVAC Engineer

1. Paul A. Pouliot
2. License #0402045575
3. Responsible for Sections 15042, 15061, 15064, 15065, 15091, 15372, 15712, 15715, 15806, and 15905.



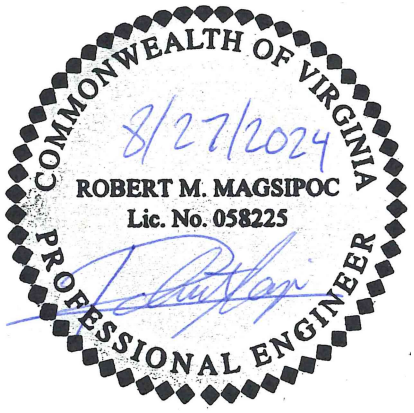
D. Structural Engineer:

1. Kevin M. Basili
2. License #0402055637
3. Responsible for Sections 03015, 03303, 03600, 04220, 05051, and 05502.



E. Electrical Engineer:

1. Robert M. Magsipoc
2. License # 0402058225
3. Responsible for Sections 15105, 16010, 16011, 16052, 16055, 16056, 16057, 16059, 16063, 16064, 16070, 16071, 16080, 16090, 16131, 16223, 16243, 16246, 16283, 16286, 16293, 16296, and 16501.

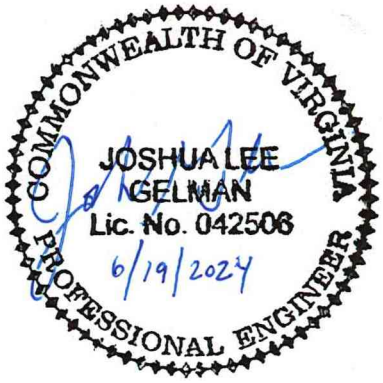


F. Civil Engineer

1. Christopher D. Mata
2. License # 0402058063
3. Responsible for Sections 02060, 02200, 02300, 02333, 02370, 02660, 02720, 02740, 02750, 02760, 02920, and 02930.



G. Automation
   1. Joshua L. Gelman
   2. License # 0402042506
   3. Responsible for Sections 13300, 13610, 13612, and 13614



END OF DOCUMENT 00001

SECTION 00010

TABLE OF CONTENTS

CONTRACT REQUIREMENTS

Section	Title
00001	Seals Page
00010	Table of Contents

SPECIFICATIONS

DIVISION 01 – GENERAL REQUIREMENTS

Section	Title
01110	Summary of Work
01140	Limitations on Sequence of Construction
01200	Measurement and Payment
01250	Contract Modification Procedures
01260	Standard Project Forms
01290	Applications for Payment
01310	Project Meetings
01320	Construction Schedule
01330	Submittals
01410	Regulatory Requirements
01420	References
01450	Quality Control
01500	Construction Facilities and Temporary Controls
01600	Materials and Equipment
01615	Wire and Equipment Identification
01630	Product Options and Substitutions
01710	Cleaning
01720	Field Engineering and Surveying (Above Ground)
01770	Contract Closeout
01780	Project Record Documents
01782	Operation and Maintenance Data
01800	Equipment and System Training

DIVISION 02 – SITE CONSTRUCTION

Section	Title
02060	Soils and Aggregates for Earthwork
02200	Site Clearing
02300	Earthwork
02333	Trenching and Backfilling
02370	Erosion and Sedimentation Control
02660	Geotextiles for Earthwork
02720	Aggregate Base Courses

02740 Asphalt Paving
02750 Concrete Paving
02760 Concrete Paving Joint Sealants
02920 Turf and Grasses
02930 Plants

DIVISION 03 – CONCRETE

Section	Title
03015	Modifications to Existing Concrete
03303	Cast-In-Place Concrete and Reinforcing
03600	Grouting

DIVISION 04 – MASONRY

Section	Title
04220	Concrete Unit Masonry

DIVISION 05 – METALS

Section	Title
05051	Post-Installed Anchors and Reinforcing Bars
05502	Metal Fabrications

DIVISION 09 – FINISHES

Section	Title
09069	Paint Color Schedule
09967	Atmospheric Protection and Plant Service Areas Coatings

DIVISION 13 – SPECIAL CONSTRUCTION

Section	Title
13300	Process Control System Input-Output List
13610	Process Control and Enterprise Management Systems General Provisions
13612	Process Control System Testing
13614	Process Control Descriptions

DIVISION 15 – MECHAINCAL

Section	Title
15042	Common Motor Requirements for HVAC Equipment
15061	Hangers and Supports for HVAC Piping and Equipment
15064	Vibration Controls for HVAC
15065	Identification for HVAC Piping Equipment
15091	Duct Insulation

15105	Low-Voltage Motor Requirement for Process Equipment
15372	Registers and Grilles
15712	Metal Ducts Accessories
15715	Air Duct Accessories
15806	Packages Terminal Air-Conditioner, Outdoor, Wall-Mounted Units
15905	Testing, Adjusting, and Balancing for HVAC

DIVISION 16 – ELECTRICAL

Section	**Title**
16010	Supplemental Requirements for Electrical
16011	Facility Performance Requirements for Electrical
16052	Low-Voltage Electrical Power Conductors and Cables
16055	Control-Voltage Electrical Power Cables
16056	Grounding and Bonding for Electrical Systems
16057	Hangers and supports for Electrical Systems
16059	Boxes and Covers for Electrical Systems
16063	Underground Ducts and Raceways for Electrical Systems
16064	Sleeves and Sleeve Deals for Electrical Raceways and Cabling
16070	Identification for Electrical Systems
16071	Power System Studies
16080	Commissioning of Electrical Systems
16090	Electrical Power Monitoring and Control
16131	Conduits for Electrical Systems
16223	Low-Voltage Distribution Transformers
16243	Switchboard
16246	Panelboards
16283	Fuses
16286	Enclosed Switches and Circuit Breakers
16293	Soft-Start Motor Controllers
16296	Variable-Frequency Motor Controllers
16501	Lighting

Appendix A – Geotechnical Engineering Report
Appendix B – Building Permit

END OF SECTION 00010

SECTION 01110

SUMMARY OF WORK

AND MISCELLANOUS REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description of Work

B. Contractor Use of Site and Premises

C. Intent of Contract Documents

D. Copies of Contract Documents Furnished to Contractor

E. Supplemental Drawings

F. Coordination

1.02 DESCRIPTION OF WORK

A. Work is generally described as the replacement of all electrical equipment in the Reston pump station. The Project will include the demolition of the existing utility transformer and its replacement, to be coordinated with Dominion Energy. Additionally, HVAC improvements are required including upsizing the equipment to meet the heat demands of the new equipment.

The above description shall serve as general information only and shall not be construed to limit the Contractor's responsibility or obligation to comply with the Contract Documents and Detailed Technical Specifications. The Contractor is referred to the Contract Drawings and following Specifications for the complete scope of Work.

1.03 CONTRACTOR'S USE OF SITE AND PREMISES

A. Unfavorable Construction Conditions: During unfavorable weather, wet ground, or other unsuitable construction conditions, the Contractor shall confine his operations to Work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would adversely affect the quality or efficiency thereof, unless special means or precautions are taken by the Contractor to perform the Work in a proper and satisfactory manner. The Contractor shall, however, maintain suitable all-weather access to all portions of the Work Site.

B. Site Administration: The Contractor shall be responsible for all areas of the Site used by him and all subcontractors in the performance of the Work. He shall exert full control over the actions of all employees and other persons in the use and preservation of property and existing facilities except such controls as may be specifically reserved for the Owner or others. The Contractor may require all persons on the Site to observe the same regulations as he requires of his employees and representatives. Owner’s employees, Authorized Representatives, Consultants, the Engineer and the Engineer's employees will not be subject to the provisions of this paragraph.

1.04 INTENT OF CONTRACT DOCUMENTS

A. Contract Documents Complementary: All Work called for in the Contract Documents applicable to this Contract, but not shown in the Drawings in their present form, or shown in the Drawings and not specifically called for in the Specifications, shall be of like effect as if shown or mentioned

in both. Work not specified in either the Drawings or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the Work, is required, and shall be performed by the Contractor as though it were specifically delineated or described.

B. Omission or Silence of Contract Documents: The apparent silence of the Contract Documents as to any detail, or the apparent omission from them of a detailed description concerning any Work to be performed or materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only materials and Workmanship of the best quality are to be used and interpretation of these Specifications shall be made upon that basis.

1.05 DOCUMENTS FURNISHED TO CONTRACTOR

A. Number of Copies to be Furnished: The Contractor will be furnished, at no cost, up to 10 full size copies of the Contract Documents at the Preconstruction Conference.

1. Additional copies of Contract Documents when requested will be furnished to the Contractor at cost of reproduction.

A. The Contractor will be furnished, at no cost, with a CD containing [conformed] Contract Documents if required at the Preconstruction Conference. All electronic files will be provided in PDF format.

B. Copies of Contract Documents for Subcontractors: The Contractor shall, without expense to the Owner, furnish each of the subcontractors, manufacturers, and materialmen such copies of the Contract Documents as may be required for his Work.

C. Record Copy of Contract Documents: The Contractor shall keep one record copy of all Specifications, Drawings, Addenda, Change Orders, Supplemental Drawings, and Shop Drawings at the Contractor's office at the Site, if applicable, in good order and annotated to show all changes made during the construction process in accordance with Section 01780. The Engineer will inspect the record set of drawings and specifications on a monthly basis prior to preparation of the monthly progress payment; and in the event said drawings and specifications are not up-to-date, the monthly progress payment may be withheld until the record set of drawings and specifications are brought up-to-date. Such Documents shall be made available to the Engineer at all times and shall be delivered to the Owner upon completion of the Work.

1.06 SUPPLEMENTAL DRAWINGS

A. Supplemental Drawings: When, in the opinion of the Engineer, it becomes necessary to explain more fully the Work to be done, or to illustrate the Work further, or to show any changes which may be required, Drawings known as Supplemental Drawings with specifications pertaining thereto will be prepared by the Engineer and 10 copies thereof will be given to the Contractor.

B. Clarification Procedure: The Contractor may request a clarification of the Drawings or Specifications from the Engineer through the following procedure:

1. Forms: The standard clarification form shall be used. The upper portion of this form shall be completed and signed by the Contractor. The completed form shall be forwarded to the Engineer for a response. The Contractor should indicate a preferred reply date. The Engineer’s clarification review period shall be 14 consecutive calendar days in length and shall commence on the first calendar day immediately following the date of arrival of the clarification at the Engineer’s office. In no cases shall the Contractor’s preferred reply date be less than the 14 day review period.

a. The Contractor will assign the clarification a sequential number.

b. The Engineer will review the clarification with the appropriate parties and the Owner.

c. The Engineer will complete and sign the lower portion of the clarification.

d. A copy of the completed clarification will be returned to the Contractor.

e. The completed clarification distribution will be noted on the clarification form.

f. A copy of the completed clarification will be sent to the Owner.

2. Clarification Log: A clarification log will be maintained by the Engineer and will be used to review the status of outstanding clarifications during each progress meeting.

1.07 COORDINATION

A. The Contractor shall verify all dimensions, quantities and details shown on the Drawings and Supplemental Drawings, equipment, material, finishes, and other such listings or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts and discrepancies. This shall not relieve the Contractor of full responsibility for unsatisfactory Work, faulty construction, or improper operation resulting therefrom, or from rectifying such conditions at his own expense. He shall not be allowed to take advantage of any errors or omissions. All equipment, materials, finishes, and other such listings are given for the convenience of the Engineer and Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in Work to be done under the Contract.

1.08 CLARIFICATION REQUEST FORM

A. Clarification request form found in Section 01260 shall be used for clarification.

1.09 PIPING ALIGNMENT AND EQUIPMENT LOCATION VERIFICATIONS

A. The Contractor shall field verify the suitability of pipe alignments and equipment locations with respect to the location of existing facilities. These verifications shall be made on the submitted layout and shop drawings and before pipe and fittings are ordered from suppliers.

B. The Contractor shall be responsible to make minor adjustments of lengths or elevations in new construction necessary to suit existing facilities at no additional cost to the Owner.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01110

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01140

LIMITATIONS ON SEQUENCE OF CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Operation of Existing Facilities

B. Limitation of Sequence of Construction

1.02 RELATED SECTIONS

A. Section 01320 - Construction Schedule

1.03 OPERATION OF EXISTING FACILITIES

A. The work under this project shall be so conducted that the Owner's existing facilities will be maintained in full operation at all times except for operation interruptions provided for under this section.

B. The Contractor shall keep the Engineer and the Owner fully advised by prior written documentation as to his proposed plans for carrying out the work and obtain the Owner's and Engineer's prior approval for all phases of his operations as hereinafter specified.

C. Any temporary structures, connections, piping, and other work necessary to maintain service during the construction period shall be made as a part of the work.

D. All work shall be performed with care to avoid damage to existing structures and equipment. Before starting work on any modifications to existing facilities, the Contractor shall submit a plan to the Engineer for approval, comprising a detailed sequence of operations for these modifications and complete details of temporary facilities which demonstrates that operation of these existing facilities will be maintained. All construction shall be in accordance with the schedule accepted per Section 01320. At no time shall the service performed by any operating pipeline, equipment or structures be interrupted without specific prior approval of the Owner and Engineer.

E. Temporary facilities and equipment shall be provided as required and directed to maintain pipelines, equipment, systems, processes, auxiliaries, appurtenances and structures in service. Any temporary work not required after completion of the final work shall be promptly removed.

F. The Contractor shall not operate or adjust the operation of any existing facility except under the specific direction of the Owner or Engineer.

G. The Contractor shall at all times maintain Owner access to sample stations and areas that must be accessed for facility operations.

H. All costs associated with maintaining the existing facilities in operation shall be included in Contract Item No. 1A and 1G, and no separate payment will be made thereof.

I. The Contractor shall keep PLC and associated communications including smoke and intrusion monitoring powered and operating 24 hours, 7 days a week. The Contractor shall keep breakers 13 and 14 of the PLC energized to allow for the communication of alarms and monitoring systems.

1.04 LIMITATIONS ON SEQUENCE OF CONSTRUCTION

A. In accordance with the requirements of Section 01320 – Construction Schedule, the Contractor shall prepare and submit a comprehensive schedule of his proposed sequence of construction of the various parts of the project for review by the Engineer.

B. At all times during the Contract Period, the Contractor will, as part of the Work and at no additional cost to the Owner, coordinate its performance of the Work with the activities and operations of the Owner and with those of any separate contractors who are engaged by the Owner to perform construction or construction-related services at the site of the Project (the "Separate Contractors"). The Contractor will coordinate its construction and related operations with the Owner's operations and with the construction and related operations of any Separate Contractors, in each case to the extent necessary to achieve the timely and satisfactory completion of the Work in accordance with the Contract Documents, and in such a manner as to avoid delaying, interfering with, or otherwise placing undue burden upon the activities and operations of the Owner or any Separate Contractor. At all times during performance of the Work, the Contractor will afford the Owner and each Separate Contractor reasonable access to the existing facilities for performance of their respective activities. Except as expressly authorized in advance by the Owner, the Contractor will not take any action, or omit to take any action, that will: (i) delay, interfere with, or otherwise unduly burden the activities of the Owner or of any Separate Contractor; (ii) obstruct reasonable access by Owner and any Separate Contractor to or from the site of the Owner's or any Separate Contractor's activities and operations.

C. The Contractor shall be permitted to remove the Reston pump station completely from service for a maximum of one (1) 90 consecutive day shutdown period between October 1 and April 1, pending all equipment is on-site or contractor's off-site storage prior to the shutdown. This 90 consecutive day shutdown period cannot be concurrent with any shutdowns related to the Popes Head Pumping Station Electrical Upgrades project. During this time, the Contractor must perform the Work associated with the demolition of existing equipment, installation of new equipment, field testing, inspection, and acceptance. All pumps must be fully tested and in service by the end of the 90 consecutive day shutdown period, and be able to be operated from the PLC.

D. The Contractor shall remove and install one of the three new motors, along with its baseplate as specified in Section 15105 and shown on the Drawings, 30 days immediately prior to the Reston pump station 90 consecutive day shutdown. This is to confirm motor, baseplate, and existing pumps will align prior to removal and replacement of the remaining two motors. Contractor cannot remove a motor for replacement until all materials have been delivered to site or delivered to Contractor's off-site facility. This first motor to be replaced shall be at the Owner's discretion. The Contractor may leave this motor without power through the shutdown period referenced above. Once the two remaining motors are installed, the Contractor shall follow testing and start-up for all three motors as specified in Section 15105.

E. Ensure all major equipment (motors, switchgear, motor starters, HVAC units) will be onsite or at the Contractor's off-site storage location ready for installation prior to the pump station shut down.

F. Provide storage of equipment that will arrive on site prior to installation.

G. The Contractor shall submit, for approval by owner, a detailed plan for all facility shutdowns and tie-ins of new work. Contractor shall notify the Owner and Engineer at least 28 days in advance of an approved shutdown and/or tie-in.

H. Work on this Contract shall be coordinated with the operation of the facility. The Contractor shall notify the Engineer of the Contractor's planned procedures for each specific alteration of existing facilities before the alteration begins. The Contractor shall not begin any alteration until specific permission has been granted by the Owner in each case and shall provide the Engineer and the Owner with sufficient advance notice as not to impact the Contractor's schedule. The making of connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be completed within the time frames specified herein.

I. Authorized Owner personnel will perform all operations for the operational functions of the existing facilities identified as necessary to facilitate the Work of the Contractor and approved by the Owner, upon recommendation of the Engineer.

J. If it is necessary for proper operation or maintenance of the existing facilities, the Contractor shall reschedule his operations, at no additional cost, so that his work will not conflict with necessary operation or maintenance of the facility. Such rescheduling shall not be cause for a time extension except as provided for in Article 8 of the General Conditions.

K. The Contractor shall maintain safe passage through all access roads to existing facilities and to all parts of existing facilities.

L. The Engineer shall be the sole judge of when the Contractor's operations are causing interference with existing facility operations, and his orders and instructions shall be carried out without delay.

M. The Contractor is required to perform certain functions in an order which will allow the existing facilities to remain in operation and to allow other facilities to be completed on schedule. The requirements specified herein shall be incorporated into the Contractor's sequence of construction and shall apply at all times, except as may be modified in writing by the Engineer.

END OF SECTION 01140

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01200

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measurement Authority

B. Unit Quantities Specified

C. Schedule of Contract Items

D. Payment

E. Defect Assessment

F. Non-Payment for Rejected Work

1.02 MEASUREMENT AUTHORITY

A. Measurement: The Owner will take all measurements and compute quantities accordingly.

B. Assistance: Assistance to the Owner in the form of necessary equipment, and qualified personnel shall be provided by the Contractor as required for taking measurements.

1.03 UNIT QUANTITIES SPECIFIED

A. Quantities: Quantities and measurements indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the Engineer and recorded in his daily report shall determine the payment.

B. Actual Work: If the actual Work requires more or fewer quantities than those quantities indicated, the required quantities shall be provided at the unit prices contracted.

C. Units of Work: The intention of the unit prices is to provide a complete, functioning unit which may include Work from several Specification Sections. All the Work which is required or which can reasonably be inferred to be required in a unit price item to deliver a complete, functioning unit shall be included.

1.04 DEFINITION OF BID ITEMS

A. “Lump Sum”: The price bid for each Lump Sum Contract Item shall include all costs in connection with the proper and successful completion of the Work, including furnishing all materials, equipment, supplies and appurtenances; providing all construction plant equipment and tools; and performing all necessary labor and supervision and training to fully complete the Work. All Work not specifically set forth as a Contract item in the Bid Form shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the prices bid.

B. “Bid Allowance”: Contract Items in the Bid Form that are designated “Bid Allowance” cover certain items of work that will be paid for separately from other Contract items. Payment will be made to the Contractor by the Owner for actual costs invoiced to the Contractor for services plus allowable contract mark-ups, and other items selected by the Owner as

defined herein and under each Bid Allowance item. A change order may be issued for the work associated with each Bid Allowance item to adjust the contract amount based on the difference between the actual costs and the Bid Allowance amount. Contractor shall submit original invoices from suppliers to support requests for payment for all bid allowance items.

C. "Contingent Contract Item": The purpose of Contract Items in the Bid Form that are designated "Contingent Contract Item" is to establish unit prices for work not included in other bid items that is (a) ordered by the Engineer beyond the lines and grades shown on the Drawings or (b) indicated for payment on a unit price basis. No payment shall be made under any Contingent Contract Item for work performed by the Contractor for his own convenience or due to his negligence in executing the Work. Work under Contingent Contract Items shall be performed only as and when ordered by the Engineer. The Engineer has the right to order that contingent work be provided in smaller or larger quantities than the estimated quantity indicated in the Bid Form. The Contractor shall not have any right to demand payment for, and will not be paid for, any costs associated with the item, including but not limited to overhead and profit, due to the fact that the item was not used in the Work or was used in smaller or larger quantities than those indicated in the Bid Form. The Contract Sum will be subject to adjustment according to final measured quantities and the unit prices in the Bid will apply to such final quantities.

1.05 ALLOWANCE REQUIREMENTS

A. At the earliest feasible date after Contract Award, advise the Owner of the date when the final selection and purchase of each product or system described by an allowance must be completed in order to avoid delay in performance of the Work.

1. When requested by the Owner, obtain a minimum of three proposals for each allowance for use in making final selections; include recommendations that are relevant to performance of the Work.

2. Purchase products and systems as selected by the Owner from the designated supplier.

B. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Order.

C. Submit invoices or delivery slips to indicate actual quantities of materials delivered to the site for use in fulfillment of each allowance.

D. Inspect products covered by an allowance promptly upon delivery for damage or defects.

E. Coordinate materials and their installation for each allowance with related materials and installation to ensure that each allowance item is completely integrated and interfaced with related construction activities.

1.06 SCHEDULE OF CONTRACT ITEMS

A. Base Bid

1. Contract Item 1A (Lump Sum): All Work to Complete Reston Pump Station Electrical Upgrades under Project 0125A Division 041, except that included under Contract Items 1B through 1G.

2. Contract Item 1B (Bid Allowance), Dynamic Analysis for New Motors

    a. If during the Work, it is found that additional vibration testing and analysis is required beyond what is outlined in Section 15105 and it is authorized in writing by the Owner, this Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

3. Contract Item 1C (Bid Allowance), Misc. Modifications to Pump/Motor Baseplate

    a. If during the Work, it is found that additional modification is required to the pump/motor pad and/or baseplate beyond what is shown or specified and it is authorized in writing by the Owner, this Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

4. Contract Item 1D (Bid Allowance) for Additional Electrical Work

    a. It is believed that these Specifications adequately describe the Work to be performed. If during the Work, it is found that additional electrical work is required and it is authorized in writing by the Owner, this Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

5. Contract Item 1E (Bid Allowance) for Additional Sitework

    a. It is believed that these Specifications adequately describe the Work to be performed. If during the Work, it is found that additional site work is required and it is authorized in writing by the Owner, this Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

6. Contract Item 1F (Bid Allowance) for Additional HVAC Work

    a. It is believed that these Specifications adequately describe the Work to be performed. If during the Work, it is found that additional HVAC work is required and it is authorized in writing by the Owner, this Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

7. Contract Item 1G (Bid Allowance) for Handling of Legally Regulated Materials

    a. If during the Work, the Contractor verifies the presence of legally regulated material and remediation, and handling is required then Contractor shall request approval to use this allowance in writing by the OWNER. This Work shall be paid for under the bid allowance, including all materials, equipment, labor, supplies, overhead, insurance, and profit.

1.07 PAYMENT

A. Payment Includes: Full compensation for all required labor, products tools, equipment, plant, transportation, services and incidentals; erection or application of an Item of the Works, overhead and profit.

B. Final Payment: Final Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the Engineer multiplied by the unit price for the Work which is incorporated in or made necessary by the Work.

1.08 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to the specified requirements.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, the Engineer will direct that the defective Work may remain or be partially replaced and the price will be adjusted to a new price at the discretion of the Owner.

1.09 NON-PAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined as unacceptable before or after placement.

3. Products not completely unloaded from the vehicle.

4. Products placed beyond the lines and grades of the required Work.

5. Contractor supplied products remaining on hand after completion of the Work.

6. Loading, hauling and disposing of rejected Products.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01200

SECTION 01250

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Change Orders

B. Work Orders

1.02 DEFINITIONS

A. Change Order: Refer to the definition in the General Conditions.

B. Work Order: Refer to the definition in the General Conditions.

C. Overhead: Refer to the definition in the General Conditions.

D. Extra Work: Refer to the definition in the General Conditions.

1.03 SUBMITTALS

A. Labor Rates: Submit a listing of employees, in accordance with Section 01330, providing the employee's name, job title or description and the hourly rate of pay including straight and overtime rates.

1. Provide submittal within 14 days after the issuance of the Notice to Proceed for review and acceptance. Annual updates of labor rates may be submitted for review and acceptance if necessary.

2. Payment for Extra Work will be based on the rates given in this submittal.

1.04 CHANGE ORDERS

A. Initiation: Change Order Proposal

1. Initiated by Engineer or Owner. The Owner or the Engineer may issue a Request for Change Order Proposal. The request will contain a description of the intended change with supplementary or revised Drawings and Specifications as applicable and the projected time for accomplishing the change.

2. Initiated by Contractor: The Contractor may propose a change in the Work by submittal of a Change Order Proposal to the Engineer, with a copy to the Owner. The Change Order Proposal will include:

a. a detailed description of the Contractor's proposed change to the Work, including supplementary or revised Drawings and Specifications, as applicable;

b. a statement of the reason for the proposed change and an explanation as to why implementation of such a change would benefit the Project;

c. a statement of the impact of the proposed change, if any, on the Contract Period and/or the Contract Sum; and

d. such other supporting documentation as may be necessary under the circumstances to permit the Owner to fully evaluate the information set forth in (a) through (c) above.

3. By submittal of a Change Order Proposal hereunder, the Contractor certifies and agrees as follows:

a. He has carefully reviewed and evaluated the proposed change to the Work and determined that implementation of such a change is in the best interests of the Project; and

b. The information set forth in the Change Order Proposal (including the statement of impact set forth in Item 2c above is accurate and complete, to the best of his knowledge and belief.

B. Execution of Change Order Proposal:

1. When a Proposal is requested for a change in the Work, the Contractor shall submit his proposal within 14 days following receipt of the Request for Change Order Proposal. The Proposal shall state the increase or decrease, if any, in Contract Period and Contract Sum.

2. The Contractor shall explain the proposal in as much detail as requested by the Owner.

3. Any decrease in price for omitted Work shall include appropriate amounts for profit and overhead.

4. The Owner and Engineer will review the Proposal and may request additional information and documentation which the Contractor shall provide promptly.

5. If the Owner decides to proceed with the change, it will issue a change order for signature first by the Contractor and then by the Owner.

6. The Contractor shall promptly complete the approved change in the Work on receipt of the executed Change Order.

   a. Failure to sign the Change Order by the Contractor shall not relieve him from performing the Work if the Change Order is signed by the Owner.

C. Costs: The cost of both additive and deductive changes in the Work shall be determined as follows:

1. Labor: Applied labor cost of laborers, crew foreman and general foreman performing or directly supervising the Work on the Site. Also included are reasonable travel and subsistence, but only to the extent incurred.

2. Insurance and Taxes: Net premium for Workman's Compensation Insurance, taxes pursuant to the Federal Social Security Act.

3. Additional Materials: Necessary extra materials, delivered at the site.

4. Plant and Equipment: Rent for plant and equipment shall be at the cost for rentals from an independent firm (i.e. a firm which is not owned in whole or in part by the Contractor). If the equipment is owned by the Contractor or rented from a firm in which the Contractor has an interest, the rent shall be calculated in accordance with the applicable provisions and terms of the current "Cost Reference Guide for Construction Equipment" published by Dataquest.

5. Subcontractor Costs: Subcontractor's direct costs, determined by items 1 through 4 in the immediately preceding subparagraphs, plus maximum profit and overhead of 20 percent.

6. Overhead and Profit:

   a. For items 1 through 4 above: plus 20 percent

   b. For item 5 above: plus 10 percent

   c. Overhead shall also include compensation to the Contractor, and all of its subcontractors, for all indirect costs associated with or relating to the Change in the Work including, but not limited to: labor and/or equipment inefficiency, changes in sequence, delays, interferences, disruptions, impact on the unchanged Work, usage taxes, additional premiums for increases in all bonds, additional insurance premiums, supervision, field engineering and coordination, superintendence, small tools, reproduction, change order cost preparation, administration, schedule adjustments and updates, as-built documentation and updates, safety requirements, temporary

structure and offices, and all other general and administrative, home office and field office expenses.

7. During periods of downtime, the following conditions shall also apply:
   a. Payment for equipment will be on the basis of an 8-hour day.
   b. No overtime will be included.
   c. No compensation for subsistence will be included.
   d. The rates for overhead and profit will be 10 percent.
   e. No compensation for equipment overhaul, field repair and fuel expenses shall be included.

1.05 WORK ORDERS

A. Initiation: The Owner may issue a Work Order with a Notice to Proceed without a prior Request for a Change Order Proposal or the Contractor's signature.

B. Method of Compensation: The Owner will designate the method of determining the amount of compensation or credit, if any, based on one of the methods contained in this Section and the General Conditions.

C. Timing of the Work: The Contractor shall proceed with the change in the Work immediately upon receipt of the Work Order.

D. Incorporation in Contract Documents: The Work Order will be incorporated into the Contract Documents via a Change Order at a later date.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01250

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01260

STANDARD PROJECT FORMS

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The standard forms listed in this Section shall be utilized by all parties in the administration of this Contract. In an effort to promote more efficient communications between the Contractor and the Owner, the forms identified in paragraphs 3.01 and 3.02 shall be used as applicable for this Contract. Additional standard forms to be used for this project can be found in other Specification Sections. Electronic versions are available upon request but are not to be changed unless authorized in writing by the Owner.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 OWNER TO CONTRACTOR

A. Request for Change Proposal

B. Work Order

C. Record of Minor Change

D. Change Order

E. Certificate of Beneficial Use

F. Certificate of Final Completion

3.02 CONTRACTOR TO OWNER

A. Payment Breakdown

B. Application and Certification for Payment

C. Request for Clarification

D. Proposed Change Order

E. Subcontractor Qualification Form

F. Pre-Approved Contractor Form

1. This form will also be used as the updated log transmitted to the Owner on a monthly basis as a pre-requisite to any monthly progress payment.

G. Contractor’s Parking Pass Log

1. This updated log will be transmitted to the Owner on a monthly basis as a pre-requisite to any monthly progress payment.

H. Electronic Access Request and Authorization Form

1. This form is to be filled out by the Contractor and submitted to the Owner for processing.

I. Contractor’s Electronic Access and Cyber Key Log

1. This form is to be filled out by the Contractor and submitted to the Owner for processing.

J. Plant Impact Request

K. Maintenance Summary Form

L. Spare Parts and Maintenance Material Transmittal

M. Equipment and Systems Owner Instruction Form

N. Contractor’s Notice of Beneficial Use

O. Contractor’s Certificate of Final Completion

P. Consent of Surety to Final Payment

Q. Final Payment Affidavit and Release of Claims

END OF SECTION 01260

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

REQUEST FOR CHANGE PROPOSAL (RCP)

TO: RCP No.:

ATTN:

TO CONTRACTOR: You are hereby directed, pursuant to the Contract Documents, to submit a complete proposal that includes:

(1) Your estimated cost, with applicable markups, for the performance of the proposed change or deletion of a part of the work described below; and

(2) If applicable, an increase in the Contract Time or extensions of Milestone Dates supported by scheduling analysis required by the Contract Documents for such requested time extensions.

DESCRIPTION OF CHANGE:

Sketch Attached:
☐ yes ☐ no

_____
Fairfax Water Representative (Printed Name and Signature)

_____
DATE

DISTRIBUTION: (Please check)

____ Construction Department
____ [Contractor] **____Consultant**

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

WORK ORDER NO.

TO: Contractor

ATTN: REFERENCE:

YOU ARE DIRECTED TO PERFORM/OMIT THE FOLLOWING WORK IN ACCORDNACE WITH THE CONTRACT DOCUMENT:

Sketch Attached:
☐ yes ☐ no

Proposed Adjustments:

1. The proposed basis of adjustments to the Contract Sum is:
   ☐ Lump Sum ☐ Increase ☐ Decrease $_____
   ☐ Unit Price of $_____ per _____
   ☐ Time and Material basis per the Contract Documents, Not to Exceed $_____
   ☐ As Follow: _____
2. The Contract Time is Proposed to be ☐ Adjusted ☐ Remains Unchanged
   The proposed adjustment, if any, is ☐ Increase ☐ Decrease of _____ calendar days
   When signed by the Owner and received by the Contractor, this document becomes effective immediately as a Construction Work Order and the Contractor shall proceed immediately with the work promptly.
3. Preparation and execution of an appropriate Change Order will follow
4.

This Work is recommended by: _____ _____ Date: _____
Consultant Signature

This Work is accepted by: _____ _____ Date: _____
[Contractor] Signature

This Work is authorized by: _____ _____ Date: _____
Manager, Construction Signature

DISTRIBUTION: (Please check)

____ Construction Department
____ [Contractor] **___Consultant**

FORM D

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

RECORD OF MINOR CHANGE No._

FORM E

Contractor:

Plan Sheet No.:
Description of Minor Change:

Reason:

Requested By:

The above change is for record purposes only and does not alter the Contract requirements, Period or Sum. You are hereby directed to execute this minor change(s) in the work promptly.

CONTRACTOR:

By:_____ Date:_____
(Printed Name and Signature)

FAIRFAX WATER PROJECT ENGINEER

By:_____ Date:_____
(Printed Name and Signature)

Sketch Attached:
☐ yes ☐ no

DISTRIBUTION: (Please check)

____ Construction Department
____ [Contractor] **____Consultant**

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION __041__ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

CONTRACT CHANGE ORDER NO. __

TO:

ATTN:

DESCRIPTION OF CHANGE ORDER:

The following changes to the Contract Documents were agreed upon in accordance with Section 01250 Contract Modification Procedures.

_____
_____
_____
_____
_____
_____
_____
_____

ADJUSTMENT OF CONTRACT SUM:

The net change in the Contract Sum by this Change Order is summarized as follows:

Contract Sum as Awarded	$_____
Adjustment by Previous Change Orders	$_____
Adjusted Contract Sum	$_____
Addition by this Change Order No._____	$_____
Total Adjusted Contract Sum	$_____

DISTRIBUTION: (Please check)

FORM CM/7

____ Construction Department
____ [Contractor] **____Consultant**

REV.01/16

Contract No. _____
Project __0215A____ Division __041__

ADJUSTMENT OF CONTRACT PERIOD:

Commencing _____

Original Contract Period _____
Previous Change Orders _____
Change Order No. _____
Total Days _____

Original Beneficial Use Date _____
Original Final Completion Date _____

Revised completion dates are as follows:

Beneficial Use _____
Final Completion _____

This Change order constitutes full and final compensation for all matters directly or indirectly related to or arising from the changes to the Work ordered hereby (the "Changed Work"), including but not limited to, all direct and indirect costs associated with the Changed Work and any and all adjustments (of whatever nature) to the Contract Sum or to the Contract Period attributable to the Changed Work.

RECOMMENDED:
CONSULTANT

DATE: _____ BY: _____

ACCEPTED:
[CONTRACTOR]

DATE: _____ BY: _____

APPROVED:
FAIRFAX WATER

DATE: _____ BY: _____
Charles M. Murray, General Manager

DISTRIBUTION: (Please check)

FORM CM/7

____ Construction Department
____ [Contractor] **____Consultant**

REV.01/16

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

CERTIFICATE OF BENEFICIAL USE

FORM F

CONTRACTOR: CONTRACT DATE:

THE WORK SHALL INCLUDE:
The designated Work described above has been reviewed and found to be sufficiently complete for beneficial use. The date of Beneficial Use for the designated Work is hereby established as_____.

DEFINITION OF DATE OF BENEFICIAL USE FOR THE WORK

Date of Beneficial Use shall be the date as certified by the Engineer when the construction of the Work or a specified part thereof is sufficiently completed, in accordance with the Contract Documents, so that the Work or specified part can be utilized for the purpose for which it was intended.

A list of items to be completed or corrected by the Contractor is attached hereto. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

CONSULTANT _____ BY (Printed Name and Signature) _____ DATE _____

The Contractor accepts the Beneficial Use Date and agrees to complete the work on the List of items attached hereto as promptly as practical.

_____ CONTRACTOR BY (Printed Name and Signature) _____ DATE _____

Fairfax Water accepts the Work or designated portion thereof for beneficial use.

FAIRFAX WATER BY (Printed Name and Signature) _____ DATE _____

The responsibilities of Fairfax Water and the Contractor for security, maintenance, heat utilities, damage to the designated portion of the Work and insurance shall be as attached.

DISTRIBUTION: (Please check)
____ FW Construction
____ FW Director, P&E
____ Consultant
____ FW End User *(Director, T&D – water mains, Manager, Security – security, etc)*
____ Contractor

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

CERTIFICATE OF FINAL COMPLETION

FORM G

CONTRACTOR: CONTRACT DATE:

ENGINEER: CONSULTANT

Fairfax Water has inspected the Work and determined that the Work has been satisfactorily completed in accordance with the intent of the Contract Documents and that all deficient Work (if any) has been completed to the satisfaction of Fairfax Water.

The date of the final Completion of the project is established as_____, which date also identifies the commencement of the warranty period.

Nothing contained herein shall operate to release the Contractor or its sureties from any obligations under the Contract Documents or the Performance and Payment Bonds.

Agreed to by: *(The undersigned certify that they are duly authorized representatives as defined in the Contract Document)*

_____ _____
Contractor (Printed Name and Signature) Notary

Date:_____

_____
CONSULTANT (Printed Name and Signature)

Date:_____

_____
Fairfax Water, Manager of Construction

Date:_____

DISTRIBUTION: (Please check)
____ FW Construction
____ CONSULTANT ____ OTHER
____ CONTRACTOR

THIS PAGE LEFT INTENTIONALLY BLANK.

SHEET _1_ OF____
DATE: _____

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION _041_ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

PAYMENT BREAKDOWN

Item No.	Description	Quantity	Unit of Measure	Cost Per Unit	Scheduled Value A	Work Completed				Stored Materials D	Total Completed & Stored to Date		Balance to Finish F = (A-E)
						Prior Application B		Present Application C					
						Unit	Value	Unit	Value		E = (B+C+D)	%	

DISTRIBUTION: **(Please check)**

____ Manager, Construction
____ [Contractor] **____ Consultant**

FORM CM/1

REV. 02/17

ADMIN\FORMS\PAYMNT BRKDWN.DOC

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION _041_ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

APPLICATION AND CERTIFICATE FOR PAYMENT No.

TO: **Fairfax Water**
8570 Executive Park Avenue
Post Office Box 1500
Merrifield, Virginia 22116-0815

ARCHITECT/ENGINEER:

CONTRACTOR:

APPLICATION DATE: _____
PERIOD FROM: _____ TO: _____

EXPENSE CODE: ____ RESPONSIBILITY CENTER: ___

Application is made for Payment, as shown below, in connection with the Contract.
The present status of the account for this Contract is as follows:

ORIGINAL CONTRACT SUM..…….... $_____
Net Change by Change Order……....…… $_____
CONTRACT SUM TO DATE.....…... $_____

TOTAL COMPLETED & STORED TO DATE (see attached breakdown) ..... $_____
RETAINAGE____%..... $_____
TOTAL EARNED LESS RETAINAGE…….…… $_____

LESS PREVIOUS CERTIFICATES FOR PAYMENT……..… $_____
PAYMENT DUE……...…..… $_____
BALANCE TO FINISH……...……..… $_____

State of: _____County of: _____

The undersigned Contractor certifies that the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by him for Work for which previous Certificates for Payment were issued and payments received from the Owner, no employee of the Authority has received any financial benefit related to this Contract, and that the current payment shown herein is now due.

Contractor:
By: _____ Date: _____

Subscribed and sworn to before me this ____day of_____, 20__
Notary Public:

My Commission Expires: _____

CERTIFICATION BY CONSULTING ENGINEERS AND AUTHORITY

I certify that all items and amounts shown on this request are correct and that payment of the above amount is due.

Date:_____, 20____ By:_____ Title: _____

Date:_____, 20____ By:_____ Title: Manager, Construction

This Certificate is not negotiable. It is payable only to the payee named herein and its issuance, payment and acceptance are without prejudice to any right of the Owner or Contractor under their Contract.

DISTRIBUTION: (Please check)

____ Manager, Construction
____ [Contractor] **____ Consultant**

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # __0215A___ DIVISION _041_ CONTRACT NO. _____
PROJECT NAME: ____RESTON PUMP STATION ELECTRICAL UPGRADES_____

CONTRACTOR'S CERTIFICATION STATEMENT

CONTRACTOR:_____ PAYMENT APPLICATION NO.: _____

The undersigned Contractor represents and certifies that to the best of his knowledge, information and belief that:

(1) All Work for which this Application for Payment is submitted has been completed in full and in accordance with the Contract Documents;

(2) The only outstanding and due items for payment (by the Owner) with respect to the Contract are those to be paid from the funds for which Application is being made;

(3) Title to all Work, stored materials and equipment covered by this Application for Payment will pass to the Owner either upon incorporation in the construction or upon receipt of payment by the Contractor, whichever occurs first, free and clear of all liens, claims, security interests or encumbrances; and no Work, materials or equipment covered by this Application for Payment will have been acquired by the Contractor or by any other person performing the Work at the site or furnishing materials and equipment for the Project, subject to an agreement under which an interest therein or an encumbrance thereon is retained by the seller or otherwise imposed by the Contractor or such other person;

(4) All materials stored on-site or at any other location, for which payment is requested by this Application, have been properly stored and protected as required by the Contract Documents;

(5) No employee of the Authority has received any financial benefit related to this Contract;

(6) That the current payment shown herein is now due; and

(7) Due and payable amounts and bills have been paid by the Contractor for work for which previous Certificates of Payment were issued and payments received from the Owner; and all Subcontractors or suppliers have been fully and timely paid, except for retainage per the subcontract, for all work performed prior to the time encompassed within this Application for Payment, except for the following (please state Subcontractor name, amount outstanding and reason for nonpayment; *if there is no exception, please write none in the following blank*): _____

_____

By:_____ Date: _____

State of_____) County of_____) to wit: On the _____ day of _____, 20_____ before me personally came and appeared to me known, who by me duly sworn, did depose and say that he is the_____of the _____ that he has the authority to bind the above named firm; and he represents and certifies the foregoing statements are true and complete to the best of his knowledge, information and belief.

My Commission Expires:_____ By:_____ (Seal)

DISTRIBUTION: (Please check)

____ Manager, Construction
____ [Contractor] **____ Consultant**

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION __041__ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

REQUEST FOR CLARIFICATION NO. ____

Transmitted To:_____ Date:_____

Requested By:_____

Drawings No:_____ Spec Section:_____

Questions: (Provide complete description of request with sketches or photos if necessary. Present status of work and suggest a solution, if any)

Response:

By:_____
(Printed Name and Signature)

Date:_____

DISTRIBUTION: (Please check)

____ Manager, Construction
____ [Contractor] **____ Consultant**

FORM CM/4

REV. 02/17

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

Planning and Engineering Division

PROPOSED CHANGE ORDER

PROJECT: RESTON PUMP STATION ELECTRICAL UPGRADES

PCO NO.: _____ **DATE:** _____

FROM: _____ **CONTRACT NO.:** ____

PROJECT NO.: 0215A , Division 041

TO: FAIRFAX WATER **REFERENCES:**

CONTRACTOR hereby submits this request for a change in the Contract Sum and/or the Contract Period to perform all Work associated with the above-referenced Work Order or to perform or delete Work in response to the above-referenced Request for Change Order Proposal as follows:

(1) The total direct and indirect costs, with applicable mark-ups for the performance of the proposed change in the work is as follows:

$_____ (Detailed Breakdown Attached)

(2) The increase in the Contract period or extensions of Contract Milestone Dates requested for this proposed Change, supported by the scheduling analysis required by the Contract Documents for such requested time extensions, is as follows:

____ Calendar Days - Contract Period (Details Attached)

____ Calendar Days - Milestone: _____

The Contractor understands and certifies that the proposal stated herein represents all estimated direct and indirect costs and applicable mark-ups allowed by the Contract Documents and/or additional time of performance of the Work associated with this proposed Change. The Contractor further certifies that to the best of his knowledge and belief the cost and pricing data and scheduling analysis submitted herein regarding the performance of the proposed Change in the Work or the deletion of a part of the Work is complete, accurate and current. The Contractor will perform the proposed Change in the Work as directed by the Owner or Engineer.

CONTRACTOR: _____

BY: _____

DATE: _____

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

SUBCONTRACTOR QUALIFICATION FORM

The Contractor must provide all information requested herein with respect to each proposed subcontractor. Duplicates of this form may be used in order to supply the requested information with respect to each such proposed subcontractor. Any doubt on the part of the Contractor with respect to the necessity of disclosing information shall be resolved in favor of disclosure.

Please type or print clearly in black ink. The Contractor may attach additional pages if necessary, and should number any such additional pages consecutively, referencing applicable sections of this form.

PROPRIETARY INFORMATION

The Contractor, at the request of the Proposed Subcontractor, may elect to designate all information contained in this Subcontractor Qualification Form as proprietary by checking the appropriate box.

☐ The information contained in this Subcontractor Qualification Form is submitted voluntarily and deemed a trade secret or proprietary information pursuant to §11-52 of the Code of Virginia, as amended.

☐ The information contained in this Subcontractor Qualification Form is submitted voluntarily and is not considered a trade secret or proprietary information.

Subcontractor Name:_____

Subcontractor's Trade or Specialty:_____

Street Address:_____

City, State, Zip Code:_____

Telephone No._____ Fax No._____ E-Mail:_____

Primary contact with the firm:

Name:_____ Title:_____

Telephone: _____

Type of Firm:

☐ Corporation (if a corporation, provide date and state of incorporation in space below)

☐ Partnership (if a partnership, provide names of all partners, general and limited, and state of organization, as well as date of formation of partnership in space below)

☐ Individual Owner (if individual owner, provide name of owner and date of commencement of business in space below)

☐ Joint Venture (if joint venture, provide information for each party to venture and date of formation of joint venture in space below)

☐ Limited Liability Company (if limited liability company, provide names for all members as well as state of organization in space below)

Federal Employer Identification Number:_____

Virginia Contractor's License Number_____dated_____.
(If the Subcontractor does not currently hold a Virginia Contractor's License, provide a detailed description of how the Subcontractor will obtain a license prior to its commencement of any Work ((as such term is defined in the Contract Documents.))

In the spaces set forth below, please provide the information requested with regard to three contracts performed by the Subcontractor within the past 4 months which were similar in nature and scope to that proposed to be performed on behalf of the Contractor for the above-referenced Project.

1. (a) Project identification and location:_____

_____

(b) Names, title, addresses and phone numbers of the owner and the general contractor:

Owner:_____

Address:_____

Telephone:_____

Individual to Contact and Title:_____

General Contractor:_____

Address:_____

Telephone:_____

Individual to Contact and Title:_____

(c) Description of specific work performed:_____

_____

_____

(d) Subcontract price:

Original subcontract value:_____

Final subcontract value:_____

2. (a) Project identification and location:_____

_____

(b) Names, titles, addresses and phone numbers of owner and general contractor:

Owner:_____

Address:_____

Telephone:_____

Individual to contact and title:_____

General Contractor:_____

Address:_____

Telephone:_____

Individual to contact and title:_____

(c) Description of specific work performed: _____

_____

(d) Subcontract price:

Original subcontract value: _____

Final subcontract value: _____

3. (a) Project identification and location: _____

(b) Names, titles, addresses and phone numbers of owner and general contractor:

Owner: _____

Address: _____

Telephone: _____

Individual to contact and title: _____

General Contractor: _____

Address: _____

Telephone: _____

Individual to contact and title: _____

(c) Description of specific work performed: _____

(d) Subcontract price:

Original subcontract value: _____

Final subcontract value: _____

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION __041__ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

Pre-Approved Contractor Form

Prepared By: _____ Date Submitted: _____

The purpose of this form is to provide a common basis of informing Fairfax Water Security Guards of Contractors who routinely visit the Treatment Plant. Individuals and representatives of companies named on this form have been pre-approved for plant access by the department completing this form and do not need to have access verified at the time of arrival.

Department Name	**Date of Submission**
Department Contact	**Telephone No.**

Name of Company	Company Contact	Telephone No.	Name of Representative Allowed Access	Type of Work	Dates of Access	Hours of Access

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION __041__ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

Contractor's Parking Pass Log

Prepared By: _____ Date Submitted: _____

Name	Company	Phone No.	Parking Permit No.	Primary Vehicle		Secondary Vehicle	
				State	Tag No.	State	Tag No.

THIS PAGE LEFT INTENTIONALLY BLANK.

Electronic Access Request and Authorization Form

To be completed by the Department requesting Access Badges or Cyber Keys for Visitors and/or Contractors

Name of Fairfax Water Employee Making This Request	**Department**	**Job Title**

Name to Appear on Cyber Key/Badge Account	
Driver's License Number **DO NOT PROVIDE SSN #**	
Home Address	
Home Telephone Number	
Responsible Division	
Name of Company	
Location of Work	
Description of Work	

Badge Type (check one)

☐ **Contractor/ Consultant (Photo Required)**
Required for all guests on-site more than 30 consecutive days
Photo can be emailed to Security Officer or can be taken in the Personnel Office at Merrifield

☐ **Visitor (No Photo Required)**
Required for all guests on-site less than 30 consecutive days
Visitor badge will be a generic badge without a photo or name of holder

☐ **Cyber Key** **Number of Keys Required** _____

List Area(s) of Required Access (Where does this person need to go?)	**Dates of Access (provide dates)**
	From: / / To: / /

Hours of Access to be Assigned (check those that apply)	**Days of Week Access is Needed (check all that apply)**
☐ Always - 24 hours/day/ 7days/week ☐ Business Hours - Mon. – Fri. 6:00 AM – 5:30 PM ☐ Special (list hours needed include AM and PM) From:_____To:_____	☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐ Holidays

I/we recommend the listed individual be issued the prescribed access:

Department Name _____ Requested by: _____
(Name of Manager)

PLEASE RETURN FORM TO
SECURITY & SAFETY OFFICE

Recommended by: _____
(Division Director)

Approved by: _____
(Security Officer)

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT #__0215A___ DIVISION __041__ CONTRACT NO. _____
PROJECT NAME:____RESTON PUMP STATION ELECTRICAL UPGRADES_____

Contractor's Electronic Access and Cyber Key Log

Prepared By: _____ Date Submitted: _____

Name	Company	Telephone	Badge Type			Dates of Access		Days of Week of Access								Hours of Access		
			Contractor	Visitor	Cyber Key	From	To	M	TUE	W	TH	F	SAT	SUN	Holiday	27/7	Business, M-F, 6am to 5:30pm	Special, List Day & Time
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
			☐	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

PLANT IMPACT REQUEST

Project Information

Project Name:	Date Submitted: Contractor Contact: Phone #:

Impact Overview

No.:	Revision:	References
Title:		Drawings: Specs.:

Purpose:

Description of activity:

Description of impact to facility:

Type (select all applicable):	
	Complete unit process outage
	Partial equipment outage
	Utility outage
	Material movement
	Excavation
	Other (Dewatering)
	Simple
	Involves confined space entry
	High Risk
	Critical

Proposed Timing (Submit min 2 weeks in advance)				
	Start		End	
	Date	Time	Date	Time
Impact				
Work hours				
Notes:				

Requested Courtesy Response to Accommodate Scheduling: Date: _____

Impact Details

With this request, the following is being submitted for the impact (select all that apply):

	This is a simple impact, not additional items are being submitted Detailed summary of buildings, processes, equipment, areas impacted (required)
	Status of all impacted items during duration of activity (required)
	Status of all impacted items post impact activity (when outage is "over") (required)
	Work plan for completion of activity (required)
	Sketch/drawings of proposed work (as appropriate)
	Identification of required Owner coordination activities (activity, time, etc.) if action from Owner required
	Temporary facilities plan (as appropriate)
	Material movement plan, including material moved, means of movement, final disposal, spill prevention and control measures (required for all material movement)

Simple Impact Information (for impacts requiring no/minimal supplemental information	
Impacted Item	Impact type (space, electrical, I&C, natural gas, CW, APW, road, equipment, etc.)

Requested Owner Support:

Other Details (Material Needed, Specialty Services, Subcontractors, Contingency Plan):

Contractor's Certification:

I hearby certify that this request is made after review of the contract requirements and impacts to plant operations, that we are properly prepared with all labor, material, equipment and subcontractors, we have contingency plans in place, and will provide notice as early as possible should our plans change for any reason.

Signature:_____ Date:_____

Coordination/Approval (For Owner/Engineer Use Only)				
	Approve	Reject	Date	Notes
Resident Engineer				
Project Engineer				

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

MAINTENANCE SUMMARY FORM

1. EQUIPMENT ITEM: _____

2. LOCATION: _____

3. MANUFACTURER: _____

4. EQUIPMENT/TAG NUMBER(S): _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): _____

6. NAMEPLATE DATA (hp, voltage, speed, etc.): _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

   a. Name: _____ Telephone No.: _____

   b. Address: _____

8. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

9. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

10. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

11. QUALITY CONTROL: _____

12. PRICE/COST OF ASSET: _____

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

SPARE PARTS AND MAINTENANCE MATERIAL TRANSMITTAL

To Owner: _____ Date: _____

From Contractor: _____

Contractor shall package extra material, maintenance materials, spare parts, and tools in clearly identified boxes; indicate manufacturer's name, trade name, part name, stock number, size, color, etc. Indicate which item maintenance material is to be used with, piece of equipment part or tool is for, or where extra material is to be used. Indicate name, address, and phone of closest supplier.

SECTION	DESCRIPTION	QUANTITY

OWNER'S VERIFICATION & ACCEPTANCE:

Accepted by: _____ Date: _____

Contractor shall forward copy of this transmittal to the Engineer.

DISTRIBUTION: ☐ OWNER ☐ CONTRACTOR ☐ ENGINEER

END OF TRANSMITTAL

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

EQUIPMENT AND SYSTEMS OWNER INSTRUCTION REPORT

Contractor: _____

System or equipment: _____

Specification Section: _____

NOTE: Contractor's Representative shall maintain and complete this report during course of instruction.

PRELIMINARY INFORMATION

To be completed by Contractor:

Proposed dates for instruction period: _____ to _____.

Contractor Representative conducting instruction: _____.

Number of hours of instruction required by Contract Documents: _____.

To be completed by Owner:
Owner's personnel to be instructed (Designate supervisor if required.)

_____
_____
_____
_____
_____

INSTRUCTION LOG						
Date	**No. Hours**	**Material Covered**	**Instr. Init.**	**Owner's Personnel Receiving Instruction**	**Init.**	**Comments**

Total Hours Completed: _____ Instructor's Signature: _____

Date Instruction Completed: _____ Owner's Signature: _____

Distribution: ☐ Owner ☐ Engineer ☐ Contractor

END INSTRUCTION REPORT

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

CONTRACTOR'S NOTICE OF BENEFICIAL USE

DATE OF ISSUANCE: _____ CONTRACT DATE: _____

WORK OR DESIGNATED PORTION OF WORK SHALL INCLUDE: _____
_____
_____

Work performed under this Contract has been thoroughly inspected and is considered to be sufficiently complete, in accordance with Contract Documents, so Owner can occupy or utilize Work or designated portion thereof for its intended use.

☐ Certificates of inspections indicating compliance with requirements of governing authorities are attached hereto.

☐ Certificate of Occupancy have been obtained from governing authorities, are attached hereto.

☐ A comprehensive list of items to be completed or corrected, prepared by Contractor is attached, hereto. Failure to include any items on such list does not alter responsibility of Contractor to complete all Work in accordance with Contract Documents.

Contractor will complete or correct Work by: _____

_____	_____	_____
CONTRACTOR	BY	DATE

OWNER (agrees) (does not agree) to accept portions designated above separately from the rest of the Project.

Owner intends to utilize, occupy or take use on: _____

_____	_____	_____
FAIRFAX WATER	MANAGER, CONSTRUCTION	DATE

The Work designated above, has been determined to be:

☐ Sufficiently complete and a Certificate of Beneficial Use will be issued.

☐ Not complete for the following reasons: _____
_____
_____

_____	_____	_____
CONSULTANT	BY	DATE

DISTRIBUTION: (Please check)

____ Manager, Construction

____ [Contractor] **____ Consultant**

THIS PAGE LEFT INTENTIONALLY BLANK.

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

CONTRACTOR'S CERTIFICATE OF FINAL COMPLETION

CONTRACT DATE: _____

This is to certify that I am an authorized official of, and have been properly authorized by said firm or corporation to certify following: I know of my own personal knowledge, and do hereby certify on behalf of Contractor, that Work has been reviewed and thoroughly inspected for compliance with Contract Documents, that Work has been completed, in accordance with Contract Documents and Contract is fully performed, that all equipment and systems have been tested and are operating satisfactorily, that all Contract closeout requirements have been completed satisfactorily and submitted, know of no substantial reason that insurance will not be renewable to cover period required by Contract Documents, and Work is ready for final inspection and acceptance.

Attached are three (3) copies of following documents, which are required prior to final payment:

- ☐ Final Application for Payment.
- ☐ Contractor's Affidavit of Payments of Debts and Claims: AIA Document G706.
- ☐ Contractor's Affidavit of Release of Liens: AIA Document G706A.
- ☐ Consent of Surety (if any) to Final Payment: AIA Document G707.
- ☐ Certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least forty five (45) days' prior written notice has been given to Owner.
- ☐ The list(s) of punch items which were to be completed and corrected, with each item initialed to indicate Contractor has verified completion or correction of each.
- ☐ List of Subcontractors and equipment suppliers.
- ☐ Letter of site as-built approval from Fairfax County LDS.
- ☐ If required by Owner, other data establishing payment or satisfaction of obligations arising out of Contract.
- ☐ Maintenance Bond satisfactory to Owner.
- ☐ Transmittal indicating Owner has received approved Project Record Documents.

I understand that acceptance of final payment by Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at time of final Application for Payment.

CONTRACTOR: _____ BY: _____

TITLE: _____ DATE: _____

Subscribed and sworn to me this _____ day of _____

NOTARY PUBLIC: _____

My commission expires: _____

DISTRIBUTION: ☐ MANAGER, CONSTRUCTION ☐ ENGINEER

END OF CONTRACTOR'S CERTIFICATE OF COMPLETION

THIS PAGE LEFT INTENTIONALLY BLANK.

DATE: _

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

CONSENT OF SURETY COMPANY TO FINAL PAYMENT

TO:
Fairfax County Water Authority (d/b/a: Fairfax Water)
8560 Arlington Blvd.
Fairfax, Virginia 22031

CONTRACTOR: _____

CONTRACT DATE: _____

In accordance with Article 10.5 of the General Conditions of the Contract between Fairfax Water and the Contractor referenced above, the

_____ SURETY COMPANY,

On bond of

_____, CONTRACTOR,

hereby approves of the final payment to the Contractor, and agrees that no payment, however, final or otherwise, shall operate to release the Contractor or the SURETY COMPANY from any obligations to Fairfax Water under this Contract or the Performance and Payment Bonds.

(SIGNATURES ON FOLLOWING PAGE)

IN WITNESS WHEREOF,
The Surety Company has hereunto set its hand this_____ day of _____, _____

_____
Surety Company

_____
Signature of Authorized Representative

Attest:
(Seal)

_____
Title

Fairfax Water

PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # 0215A DIVISION 041 CONTRACT NO. _____
PROJECT NAME: RESTON PUMP STATION ELECTRICAL UPGRADES

FINAL PAYMENT AFFIDAVIT AND RELEASE OF CLAIMS

TO: Fairfax County Water Authority (d/b/a: Fairfax Water)
8560 Arlington Blvd.
Fairfax, Virginia 22031

FROM: _____ (the "Contractor")

Contract Between Fairfax Water and the Contractor dated _____ (the "Contract") for the aforementioned project (the Project and real property upon which it is situated are collectively referred to herein as the "Property")

The Contractor hereby (1) acknowledges receipt of all but $___, monies being withheld pending release of claims for all labor, materials, services and benefits (collectively, the "Work") provided pursuant to, and any other amounts due under, the Contract; (2) waives and releases any and all mechanics', materialman's and like liens, and all rights to file any such liens, against the Property for any or all of the Work provided by the Contractor pursuant to the Contract (regardless of whether any such lien properly may be filed against Fairfax Water's Property); (3) agrees to pay and release of record promptly all mechanics', materialman's and like liens filed by itself or others in connection with the Work provided under the Contract which may now or in the future affect the Property; (4) represents and warrants that the Contractor has fully paid all laborers, materialmen and subcontractors of the Contractor for all Work provided by them in connection with the Contract; (5) represents that neither the Contractor nor any other person with whom the Contractor has dealt has any right to file a mechanic's, materialman's or like lien against the Property or has any other claims of any nature (whether pending or threatened) on account of any Work provided by or through the Contractor; (6) waives and releases any and all actions, debts, claims and demands against Fairfax Water arising from or in connection with the Work provided by or through the Contractor pursuant to the Contract Documents; and (7) agrees to defend, indemnify and hold harmless Fairfax Water from any and all loss, cost, liability or claim (including, without limitation, court costs and attorneys' fees) arising out of: (a) any misrepresentation or breach of any of the foregoing representations, covenants and warranties, or (b) the filing or enforcement of any lien or claim of lien or any other claim by the Contractor or by any laborer, materialman or subcontractor of the Contractor or in connection with the Work covered by the Contract.

Dated:_____

_____
[Insert name of Contractor as it appears on the Contract]

By:_____
[Signature of officer or authorized agent signing for Contractor]

Name:_____
[Print name of person signing]

Title:_____
[Print title of person signing]

STATE OF_____)
CITY/COUNTY OF_____)

SUBSCRIBED AND SWORN TO before me in the above jurisdiction this _____ day of _____, _____, by the person whose name appears above.

My commission expires:_____.

[Notarial Seal]

_____
Notary Public

_____

SECTION 01290

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Submit Applications for Payment to the Engineer and Owner in accordance with the terms and schedule established by the General Conditions of the Contract and Agreement between Owner and Contractor.

B. The accepted Schedule of Values (defined under Section 01330) shall be used as the basis for the Contractor's Application for Payment.

1.02 RELATED WORK

A. Section 00500: Agreement between Owner and Contractor.

B. Section 00700: General Conditions.

C. Section 00800: Supplementary Conditions.

D. Section 01250: Contract Modification Procedures.

E. Section 01320: Construction Schedule.

F. Section 01720: Field Engineering and Surveying.

G. Section 01770: Contract Closeout.

H. Section 01780: Project Record Documents

1.03 FORMAT AND DATA REQUIRED

A. Submit applications in automated format using the Application for Payment form provided by the Owner (under Exhibits to the General Conditions). Each submittal shall be accompanied by a Compact Disk containing a spreadsheet set up in the same format as the Schedule of Values (Section 01330) providing complete documentation of all items for which payment is requested. Text and tabular data shall be in Microsoft Excel latest version for Windows format. No payment will be made until the Schedule of Values is approved.

B. Monthly updated progress schedule, employee identification logs, parking pass logs and submittal of required O&M manuals will be a prerequisite to payment.

1.04 PREPARATION OF APPLICATION FOR PROGRESS PAYMENT

A. Application Form:

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.

2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.

3. Execute certification with signature of a responsible officer of Contract firm. An original notarized signature shall appear on each copy submitted.

B. Continuation Sheets:

1. Fill in total list of all scheduled component items of Work with item number and scheduled dollar value for each item.

2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.

a. Round off values to nearest dollar, or as specified for Schedule of Values.

3. List each Change Order executed prior to date of submission at the end of the continuation sheets. List by Change Order Number, and description, as for an original component item of work.

4. To receive approval for payment on component material stored on site, submit certified true copies of the original paid invoices with the application for payment first made for these materials. Refer to Article 10, Section 00700 for payment on stored materials.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When requested, submit substantiating information with a cover letter identifying:

1. Project.

2. Application number and date.

3. Detailed list of enclosures.

4. For stored products:

a. Item number and identification as shown on application.

b. Description of specific material.

B. Submit one copy of data and cover letter for each copy of application.

C. Maintain an updated set of drawings to be used as record drawings in accordance with Section 01780. As a prerequisite for monthly progress payments, exhibit the updated record drawings for review by Owner and Engineer.

D. The Contractor shall maintain an updated construction schedule in accordance with Section 01320. As a prerequisite for monthly progress payments, contractor shall submit the updated construction schedule with the application for progress payments. If the Contractor fails to submit the required updated schedule within the time prescribed, the Engineer may withhold approval of progress payment estimates until such time as the Contractor submits the required updated schedule. Submit as required under Section 01320.

E. The Contractor shall demonstrate, as a prerequisite for monthly progress payments, compliance with all requirements specified in Section 02370 to the Engineer. If the Contractor fails to demonstrate compliance with Section 02370, the Engineer may withhold approval of progress payment estimates until such time as the Contractor demonstrates to the Engineer full compliance with the approved erosion and sedimentation control permit and Section 02370.

F. The Contractor shall provide, as a prerequisite for monthly progress payments, an accumulating cost curve (tabular and diagram), indicating schedule, forecast and actual progress.

G. The Contractor shall provide employee identification logs and parking pass logs as required under Section 01500 as a prerequisite for monthly progress payments.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in Application form as specified for progress payments.

B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01770 – Contract Closeout.

C. Submit all Project Records Documents in accordance with Sections 01770 and 01780.

D. Submit required O&M manuals per Section 01782.

E. Satisfy all other final completion and contract close-out requirements.

1.07 SUBMITTAL PROCEDURES

A. Submit Applications for Payment to the Engineer or Owner at the times stipulated in the Agreement.

B. Number: Three copies of each Application

C. When Application is found to be properly completed and corrected, three originals will be transmitted to Owner and one copy will be returned to Contractor.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01290

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01310

PROJECT MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction Conference

B. Progress Meetings

1.03 PRECONSTRUCTION MEETINGS

A. General: Prior to the commencement of Work at the Site, a minimum of one preconstruction meeting will be required.

1. Preconstruction Conference: Prior to the commencement of Work at the Site, a preconstruction conference will be held at a predetermined time and place.

B. Preconstruction Conference:

1. Attendance: The conference shall be attended by the following:

a. The Contractor and his Superintendent

b. The principal Subcontractors

c. The representatives of principal suppliers and manufacturers as appropriate

d. The Engineer and his resident project representative(s)

e. The Authorized Representatives of the Owner

f. Governmental representatives as appropriate

g. Others, as requested by the Contractor, the Owner, or the Engineer

2. Purpose: The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed, and procedures for handling such matters, established. The agenda will include the following items:

a. Transmittal, review, and distribution of Contractor's submittals

b. Processing applications for payment

c. Maintaining record documents

d. Critical work sequencing

e. Field decisions, Change Orders and Work Orders

f. Use of premises, office and storage areas, security, housekeeping, and the Owner's needs

g. Major equipment deliveries and priorities

h. Contractor's assignments for safety and first aid

2. Meeting Chairman: The Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

D. Preconstruction Survey: Before any Work is performed at the site by the Contractor, a joint preconstruction survey will be performed by the Contractor, Engineer, and Owner to review the existing conditions and record via video or digital photographs. When the survey is completed, the Owner shall be provided with a video and photographs. Following completion of the Work, the video and photographs may be used to compare conditions prior to construction to those conditions following construction to ascertain that the Site has been properly restored.

1.04 PROGRESS MEETINGS

A. Purpose: The purpose of the meetings will be to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, review safety and quality control activities, and resolve other potential problems.

B. Scheduling: The Owner and the Contractor will schedule and hold regular progress meetings at least monthly and at other times as requested by the Engineer or required by progress of the Work. The Contractor, the Engineer, and all subcontractors active on the site shall be represented at each meeting. The Contractor may, at his discretion, request attendance by representatives of his suppliers, manufacturers, and other subcontractors.

C. Meeting Chairman: The Engineer shall preside at the meetings and provide for keeping and distributing the minutes.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01310

SECTION 01320

CONSTRUCTION SCHEDULE

PART 1 - GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of submissions applicable to the Construction Progress Schedule. Detailed submittal requirements are specified in the technical sections.

1.02 CONSTRUCTION PROGRESS SCHEDULE

A. Submit the baseline schedule, reflecting major tasks and subtasks, within 20 calendar days of Notice to Proceed.

B. Work shall be scheduled using the Critical Path Method (CPM) type of network analysis. The schedule should be developed and maintained using MS Project, latest Windows version or an approved equal.

C. The Critical Path Method type construction schedule will be used to monitor job progress. The Contractor shall be responsible for providing all information concerning the sequencing, logic and duration of all activities as well as providing the initial CPM logic network (in electronic and paper form) diagram Gantt Chart and tabular report data. Once the baseline schedule is accepted by the Engineer and the Owner, the Contractor shall be responsible for providing monthly updates of the CPM schedule showing actual progress. The Contractor shall submit the computerized printout of the schedule and highlight major changes, if any, on a monthly basis. Within the first week of each month, three (3) copies of the updated schedules shall be submitted to the Owner. If requested by Owner, within the first week of each month, one CD with the electronic file of the updated schedules shall be submitted to the Owner.

D. The contractor shall provide 3-week look-ahead reports at each Monthly Progress meeting as specified in Section 01310.

E. The schedule shall show fabrication and delivery times for all major equipment items.

F. The schedule must include all required start-up and commissioning activities.

G. The Contractor shall submit a complete separate and independent schedule and detailed listing of anticipated submittals during the Contract Period. The submittal schedule shall be submitted within 30 days after Notice to Proceed. The submittal schedule shall then be accepted or revised as required by the Engineer and the Owner within 14 days after receipt, and the Contractor shall incorporate the dates and review durations into his complete CPM schedule.

H. A CPM schedule which shows a completion of any milestone or completion dates prior to the contractual completion date for that milestone or completion date may be accepted, but in no event shall be acceptable as a basis for a claim for additional cost, delay or acceleration against the Owner and Engineer and any of their authorized representatives if the early completion date is not met by the Contractor.

I. Schedule Revisions. The Contractor shall submit any proposed revisions to the accepted baseline CPM schedule to the Owner for review and acceptance. CPM revisions shall be submitted as a computerized printout of the schedule, three (3) copies, and if requested

one CD with the electronic file. All proposed revisions to activities, logic, activity durations, and critical path shall be justified in written tabular form and shall include the impact of the proposed schedule revisions on the project. The Contractor shall not make any changes in the accepted baseline CPM schedule without the prior written acceptance of the Owner and Engineer.

I. Float

1. Definition of Float. As employed in the Contract Documents, the terms “float” and “float time” shall be used interchangeably to mean the period of time between the early start date and the late start date, or the early finish date and the late finish date of any activities set forth on the Construction Schedule.

2. Ownership of Float. The Owner shall have and retain exclusive ownership of the float.

3. Float Time. The Contractor shall not be entitled to any adjustment in the Contract Period, the Construction Schedule, or the Contract Sum, or to any additional payment of any sort by reason of the loss or use of any float time. The Owner may initiate changes to the Work that absorb float time without obligation to adjust or extend the overall completion date or any intermediate completion dates set forth in the CPM network. Owner-initiated changes that affect the critical path on the CPM network shall be the sole grounds for extending (or shortening) the Contract Period. Contractor-initiated changes that encroach on the float time identified in the CPM network may be accomplished with the Owner’s prior approval. Such changes, however, shall give way to Owner-initiated changes competing for the same float time. Delays in the critical path that are not associated with proper requests for time extensions in accordance with Article 8 of the General Conditions shall be deemed to be the responsibility of the Contractor.

J. Delays to Critical Path

1. Whenever it becomes apparent from the current monthly CPM schedule update that delays to the critical path have resulted and these delays are through no fault of the Owner or Engineer and hence, that the Contract completion date will not be met, or when so directed by the Engineer, the Contractor shall take some or all of the following actions at no additional cost to the Owner.

    a. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of Work.

    b. Increase the number of working hours per shift, shifts per day, or working days per week; the amount of construction equipment; the forms for concrete work; etc., or any combination of the foregoing to substantially eliminate the backlog of Work.

    c. Reschedule activities to achieve maximum practical concurrence of accomplishment of activities, and comply with the revised schedule.

    d. The Contractor shall submit to the Owner and Engineer for review a written statement of the steps he intends to take to remove or arrest the delay to the schedule. The Contractor shall promptly provide such level of effort to bring the Work back on schedule. Should schedule delays persist, the Contractor's Surety may be asked to attend schedule update meetings.

2. Failure of the Contractor to comply with the requirements herein shall subject him to, at the Owner's sole discretion, withholding, in partial or in total, payments otherwise due the Contractor for work performed under the Contract. Any withholding of monies is not a penalty for noncompliance, but is an assurance for the Owner that funds will be available to implement these requirements should the Contractor fail to do so, since failure of the Contractor to comply with these requirements shall mean that the Contractor failed to prosecute the Work with such diligence as to ensure its completion within the contractual dates.

K. The Contractor will not be entitled to any extension of time for the completion of the Project, nor to recover any damages for any delay attributed to the Owner, the Engineer, or their agents, with respect to any delay that is alleged to have occurred during a period of time in which the Contractor has failed to provide or to maintain an approved accepted schedule that meets all requirements of the Contract Documents.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.01 PAYMENT

A. A separate fixed-price pay line item with a designated value is provided for in the Bid Form, Section 00400, Part B, for the approved Construction Schedule outlined herein. This pay item is not an allowance and the Contractor must account for the designated value noted in the bid form in its total base bid price for the project and reflected as such in the schedule of value. The payment will be made as follows:

1. 50% of the pay line item will be paid in partial amount for the submission and approval of a baseline construction schedule.

2. The final 50% of the pay line item will be paid on a percent completion basis through the Work.

END OF SECTION 01320

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01330

SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of submissions applicable to Shop Drawings, Product Data, Samples, Mock Ups, Construction Photographs, and Submittal Schedules. Detailed submittal requirements are specified in the technical sections.

B. All submittals shall be clearly identified by reference to Section Number, Paragraph, Drawing Number or Detail as applicable. Submittals shall be clear and legible and of sufficient size for presentation of data.

1.02 CONSTRUCTION PROGRESS SCHEDULE

A. Contractor shall submit to Engineer for review a schedule of the proposed construction operations in accordance with Section 01320.

B. At least monthly the schedule shall be revised and resubmitted as necessary to reflect changes in the progress of the Work.

C. Owner may require Contractor, at Contractor's expense, to add to its plant, equipment, or construction forces, as well as increase the working hours, if operations fall behind schedule at any time during the construction period.

D. If the initial progress schedule or any subsequent revision is not acceptable to Engineer, the schedule shall be revised and resubmitted as many times as necessary until the schedule is acceptable.

1.03 SHOP DRAWING SUBMITTAL SCHEDULE

A. Contractor shall submit to Engineer a schedule of submittals for the Shop Drawings and Engineering Data that are required by the specifications in accordance with Section 01320.

B. Contractor shall submit to Engineer submittals for all major equipment (as defined below) within 30-calendar days of Notice to Proceed.

   a. Major Equipment: Variable Frequency Drives, Motors, HVAC units, Switchgear, Automatic Transfer Switch, and Enclosed Circuit Breaker.

1.04 PROGRESS REPORTS

A. A progress report shall be submitted to Engineer each month with the application for partial payment. If the Work falls behind schedule, Contractor shall submit additional progress reports at such intervals as Engineer may request.

B. Each progress report shall include sufficient narrative to describe current and anticipated delaying factors, their effect on the progress schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence.

C. Each progress report shall also include three copies of the accepted graphic schedule updated to indicate actual progress.

1.05 SCHEDULE OF VALUES

A. Schedule of Values shall be submitted to Owner and Engineer for review within 20 days of the Notice To Proceed.

B. The Contractor shall prepare a bid breakdown for the Lump Sum Contract Items in accordance with Article 10B of the General Conditions. The bid breakdown shall be prepared in such manner as approved by the Engineer to permit apportionment of construction cost to the various facilities, equipment, and structures included in this Contract.

C. The lump sum bid shall be broken down by reference to the applicable Specification Sections.

D. In addition to the dollar amount for each item, the bid breakdown shall include the physical quantities of the Work required for each item. Quantities listed shall be in units of number, size, length, area, volume or weight which are customarily used and can be readily verified.

E. Equipment items requiring appreciable amounts of installation effort shall be broken down into delivery and installation costs. Process systems made up of several items of equipment shall be subdivided into their component parts.

F. The cost of preparing a bid breakdown to conform to requirements for apportioning construction costs to facilities and structures shall be included in Contract Item 1 and no additional payment will be made therefore.

G. If, in the opinion of the Owner, the cost data does not meet the requirements for a balanced bid breakdown, the Contractor shall present documentation to the Owner substantiating any cost allocation on the cost data.

1.06 SCHEDULE OF PAYMENT

A. At the time the schedule of values is submitted, Contractor shall submit to Engineer a schedule of estimated monthly payments. The schedule shall be revised and resubmitted each time an application for partial payment varies more than 10 percent from the estimated payment schedule.

1.07 SHOP DRAWINGS AND ENGINEERING DATA.

A. General

1. Shop Drawings and engineering data (submittals) covering all equipment and fabricated and building materials which will become a permanent part of the Work under this Contract shall be submitted to Engineer for review. Submittals shall verify compliance with the Contract Documents, and shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorages, and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment. When an item consists of components from several sources, Contractor shall submit a complete initial submittal including all components.

2. The Contractor may request access to electronic media files of the Contract Drawings to assist submittal preparation. The Contractor shall enter into an agreement with the Owner and Engineer to use these electronic files, and be subject to constraints under the agreement. The Contractor will be required to sign the Engineers disclaimer if electronic files are requested.

3. Where required, Shop Drawings shall be sealed by a professional engineer registered in the Commonwealth of Virginia including, but not limited to, Fairfax County building permit approvals and VDOT standards and specifications, and where indicated in the specifications.

4. All submittals, regardless of origin, shall be stamped with the approval of Contractor and identified with the name and number of this Contract, Contractor's name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

5. Contractor shall be solely responsible for the completeness of each submission. Contractor's stamp of approval is a representation to Owner and Engineer that Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that Contractor has reviewed and coordinated each submittal with the requirements of the Work and the Contract Documents.

6. All deviations from the Contract Documents shall be identified as deviations on each submittal and shall be tabulated in Contractor's letter of transmittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

7. Eight copies of each shop drawing and necessary data shall be submitted to Engineer and two copies submitted to the Owner. Engineer will return two marked copies (or one marked reproducible copy) to Contractor. When requested by the Engineer, the Contractor shall submit 3 additional copies of an approved submittal with all markups and comments incorporated as a record set submittal. Additional review time for a record set submittal shall be for the Owner (unless it is rejected as non-compliance.)

8. Facsimile (fax) copies will not be acceptable. Engineer will not accept submittals from anyone but Contractor. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.

9. Electronic Submittals: The Contractor may request approval to transmit submittals electronically in pdf or other acceptable formats. If electronic submittal is approved by the Engineer or Owner, it must contain all information required of hard copy submittals. All the electronic documents shall be searchable. Scanned or photocopied files/pages are not acceptable. Reviews will be completed and returned electronically to the website. Once the submittal has been approved by the Engineer and returned electronically to the website, the Contractor shall submit three (3) hard copies to the Owner for their records with all mark-ups and comments incorporated. Resubmission of submittals transmitted electronically shall conform to the requirements of paragraph 1.07.E of this Section.

10. Electronic Correspondence: The Contractor may submit electronic pdf format copies of project correspondence via email, followed up with the original copy via US Mail or hand delivery.

11. Submittals shall contain:

    a. The date of submission and the dates of any previous submissions.

    b. The Project title and number.

    c. Contractor identification.

    d. The names of:

        1) Contractor

        2) Supplier

        3) Manufacturer

    e. Identification of the product, with the section number, page and paragraph(s).

    f. Field dimensions, clearly identified as such.

    g. Relation to adjacent or critical features of the work or materials.

    h. Applicable standards, such as ASTM or Federal Standards numbers.

    i. Identification of deviations from Contract Documents.

    j. Identification of revisions on resubmittals.

    k. A blank space suitably sized for Contractor and Engineer stamps.

    l. Where calculations are required to be submitted by the Contractor, the calculations shall have been checked by a qualified individual other than the preparer. The submitted calculations shall clearly show the names of the preparer and of the checker.

B. Engineer's Review of Submittals.

1. Engineer's review of submittals will cover only general conformity to the Drawings and Specifications, external connections, and dimensions which affect the layout. Engineer's review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device, or item shown. Engineer's review shall not relieve Contractor of Contractor's sole responsibility for errors, omissions, or deviations in the drawings and data, nor of Contractor's sole responsibility for compliance with the Contract Documents.

2. In general, Engineer’s submittal review period will not exceed 28 consecutive calendar days in length and shall commence on the first calendar day immediately following the date of arrival of the submittal or resubmittal in Engineer’s office. Submittals requiring complex review and coordination may involve additional review time. The time required to mail the submittal or resubmittal back to Contractor shall not be considered a part of the submittal review period.

3. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.

4. Submittals will be returned to the Contractor under one of the following codes.

   Code 1 "APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

   Code 2 "APPROVED AS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

   Code 3 "APPROVED AS NOTED/CONFIRM". This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

   Code 4 "APPROVED AS NOTED/RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

   Code 5 "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

   Code 6 "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

   Code 7 “RECEIPT ACKNOWLEDGED” is assigned to acknowledge receipt of submittal that is not subject to the Engineer’s review and approval and is being filed for information purposes only.

   Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

5. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each

comment made by the Engineer on the previous submission. Additionally, the Contractor shall direct specific attention to any revisions made other than the corrections requested by the Engineer on previous submissions.

6. Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Not Approved" until resubmitted. The Engineer may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

7. Repetitive Review

   a. Shop drawings and other submittals will be reviewed no more than twice at the Owner's expense (excluding one record set review cycle). All subsequent reviews will be performed at times convenient to the Engineer and at the Contractor's expense, based on the Engineer's then prevailing rates. The Contractor shall reimburse the Owner for all such fees invoiced to the Owner by the Engineer. Submittals are required until approved.

   b. Any need for more than one resubmission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Time.

8. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least 20 working days prior to release for manufacture.

9. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

10. When the drawings and data are returned marked "NOT APPROVED", the corrections shall be made as noted thereon and as instructed by Engineer and six corrected copies (or one corrected reproducible copy) resubmitted. Facsimile (fax) copies will not be acceptable.

11. When the drawings and data are returned marked "APPROVED AS NOTED", "APPROVED", or "RECORD COPY", no additional copies need be furnished unless requested by Engineer at time of review.

C. Contractor's Responsibilities

1. Review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:

   a. Field measurements

   b. Field construction criteria

   c. Catalog numbers and similar data

   d. Conformance with related Sections

2. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company

name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets 11 in x 17 in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Submittals shall be delivered to the Engineer's site field office.

3. The Contractor shall utilize a 10 character submittal identification numbering system in the following manner:

   a. The first character shall be a D, S, or M, which represents Shop/Working Drawing and other Product Data (D), Sample (S), or Operating/ Maintenance Manual (M).

   b. The next five digits shall be the applicable Section Number.

   c. The next three digits shall be the numbers 001 to 999 to sequentially number each initial separate item or drawing submitted under each specific Section Number.

   d. The last character shall be a letter, A to Z, indicating the submission, or resubmission of the same Drawing, i.e., "A=1st submission, B=2nd submission, C=3d submission, etc. A typical submittal number would be as follows:

D 03300 008 B

D	=	Shop Drawing
03300	=	Section for Concrete
008	=	The eighth initial submittal under this section
B	=	The second submission (first resubmission) of that particular shop drawing

4. Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

5. The review and approval of shop drawings, samples or product data by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefor.

6. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

7. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

E. Resubmittal of Drawings and Data

1. Contractor shall accept full responsibility for the completeness of each resubmittal. Contractor shall verify that all corrected data and additional information previously requested by Engineer are provided on the resubmittal.

2. When corrected copies are resubmitted, Contractor shall in writing direct specific attention to all revisions and shall list separately any revisions made other than those called for by Engineer on previous submissions.

3. Requirements specified for initial submittals shall also apply to resubmittals. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) to indicate the sequence of the resubmittal.

4. If more than one resubmission is required because of failure of Contractor to provide all previously requested corrected data or additional information, Contractor shall reimburse Owner for the charges of Engineer for review of the additional resubmissions. This does not include initial submittal data such as shop tests and field tests which are submitted after initial submittal.

5. Resubmittals shall be made within 30 days of the date of the letter returning the material to be modified or corrected, unless within 14 days Contractor submits an acceptable request for an extension of the stipulated time period, listing the reasons the resubmittal cannot be completed within that time.

6. Any need for more than one resubmission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Times unless delay of the Work is directly caused by a change in the Work authorized by a Change Order or by failure of Engineer to review any submittal within the submittal review period specified herein and to return the submittal to Contractor.

F. Color Selection

1. Any color selections made by the Owner appear in Section 09900. If color selections have not been specified, Contractor shall submit color choices for Owner selection.

1.08 ELECTRICAL AND CONTROL WIRING IDENTIFICATION

A. Contractor shall verify approved submittals, provided with unique wiring identification, match actual installation of product or equipment. In the event that installation does not match wiring identification on submittal, a resubmittal and approval process shall be required at no expense to the Owner.

1.09 SOURCE (ORIGINAL) ELECTRONIC FORMAT

A. Shop Drawings and Submittals for equipment, components, and products containing documentation generated or modified specifically for this project shall be provided in their source (original) electronic format (ex. AutoCAD).

1.10 PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. If specifically required in other related Sections, submit a P.E. Certification for each item required, in the form attached to this Section, completely filled in and stamped.

PART2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer registered in the Commonwealth of Virginia and that he/she has been employed by

_____to design
(Name of Contractor)

_____
_
(Insert P.E. Responsibilities)

in accordance with Section _____for the Reston Pump Station Electrical Upgrades Project.

The undersigned further certifies that he/she has performed the design of the
_____

_____
_

_____, that said design is in conformance with all applicable local, state and federal codes, rules, and regulations, and that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the

_____
__
(Insert Name of Owner)

or Owner's representative within seven days following written request therefore by the Owner.

_____	_____
P.E. Name	Contractor's Name
_____	
P.E. Registration Number	
_____	_____
Signature	Signature
_____	_____
Address	Title
	_____
	Address

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Partial outline of the major laws, codes and requirements to be followed on the project.

1.02 REFERENCES

A. Commonwealth of Virginia Department of Health Waterworks Regulations

B. International Codes/International Code Council

C. Virginia Uniform Statewide Building Code (VUSBC)

D. Virginia Department of Transportation Road (VDOT) and Bridge Specifications

F. Fairfax County Public Facilities Manual

G. National Electrical Code (NEC)

H. Virginia Water Control Board Regulations

I. Virginia Departments of Environmental Quality (DEQ)

1.03 REGULATORY REQUIREMENTS

A. Compliance with the Law: Precautions shall be exercised at all times for the protection of persons and property. The safety provisions of all applicable laws, building and construction codes including, but not limited to, the U.S. Department of Labor Occupational Safety and Health Regulations for Construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54), shall be observed. The U.S. Department of Labor Safety and Health Regulations shall be complied with except where state safety standards have been approved by the Secretary of Labor in accordance with provisions of the Occupational Safety and Health Act, in which case compliance with state and local standards is required.

B. Work on State Highways: Contractor will obtain all permits required where Work is to be performed within the right-of-way of highways, roads, or other public areas under the control and jurisdiction of VDOT. The Contractor shall become familiar with the requirements of VDOT, particularly regarding cutting and crossing of roadways, materials, and methods of backfilling, maintenance of roadways, drainage and other structures, protection of the traveling public, final restoration of roadway surfaces, tree clearings, and restrictions on working hours, before commencing work on highways, roads and other public areas under the control and jurisdiction of VDOT. The Contractor shall comply with all the requirements of VDOT pertaining to the Work to be performed under the Contract. The Contractor shall complete all requirements of the VDOT Land Use Permit and obtain written approval and release from VDOT, before final payment will be allowed under this contract.

C. Contractor shall conform to applicable sections of the Virginia State Board of Health “Waterworks Regulations” and these Specifications during the installation, testing and disinfection of Waterworks facilities.

D. Applicable Codes: The codes listed under references of this Section are the applicable codes for this project. Other standard codes which apply to the Work are designated in the individual specification Sections.

1.04 PERMITS

A. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract Limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. Record copies of all permits shall be furnished to the Engineer and Owner.

B. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this Project.

C. The permits obtained by the Owner shall be considered part of the Contract Documents. Copies of these permits are included in the Appendix to the Contract Documents and are listed below.

1. Fairfax County Building Permit
2. Virginia Department of Transportation Land Use Permit

D. The Contractor shall abide by the conditions of permits related to the Work and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the Work by the Owner.

F. Trade Permits: The Contractor shall be responsible for obtaining his own trade permits.

G. The Contractor shall submit all required documentation for permits to be obtained by the Contractor without delay, allowing for adequate review time by approving authorities. Any delay caused by the failure of the Contractor to submit permit applications in a timely fashion or to respond to comments from reviewers, will not entitle the Contractor to an extension of time.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not used

END OF SECTION 01410

SECTION 01420

REFERENCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Abbreviations

B. Reference Standards

1.02 ABBREVIATIONS AND SYMBOLS

A. Technical Societies, organizations, other bodies: Reference to a technical society, organization, or body may be made in the Specifications by abbreviations in accordance with the following list:

AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AFBMA	Antifriction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
AREA	American Railway Engineering Association
APA	American Plywood Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials
AWPA	American Wood Products Association
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
DHI	Door and Hardware Institute
FGMA	Flat Glass Marketing Association
IEEE	Institute of Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
ISA	International Society of Arboriculture
NAAMM	National Association of Architectural Metals
NACE	National Association of Corrosion Engineers
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association Manufacturers
OSHA	Occupational Safety and Health Administration
PCI	Prestressed Concrete Institute
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry
SSPC	Steel Structures Painting Council

UL	Underwriters' Laboratories, Inc.
USACOE	U.S. Army Corps of Engineers
USBS	U.S. Bureau of Standards
USBR	U.S. Bureau of Reclamation
VDH	Virginia Department of Health
VDOT	Virginia Department of Transportation
VSWCB	Virginia State Water Control Board

B. Common Abbreviations:

AWG	American Wire Gauge
CS	Commercial Standard
Fed Spec	Federal Specifications
IPS	Iron Pipe Size
MIL	Military Specification
NEC	National Electrical Code
PS	Product Standard

1.03 REGULATORY REQUIREMENTS

A. Reference to Standards: Whenever reference is made to furnishing materials or testing thereof to conform to the standards of any technical society, organization, or body, it shall be construed to mean the latest standard, code, or specification, adopted and published at the time of the Bid unless otherwise noted.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01420

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inspection Services

B. Inspection of Materials

C. Contractor's Quality Control

D. Cost of Inspection

E. Failure to Comply with Contracts

1.02 SUBMITTALS

A. Certificates of Manufacture: The Contractor shall furnish the Engineer authoritative evidence in the form of Certificates of Manufacture that the materials and equipment to be used in the Work have been manufactured and tested in conformity with the Contract Documents. These certificates shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.03 INSPECTION OF WORK

A. Work May Be Rejected at Any Time: During the progress of the Work and until the Date of Final Completion, the Contractor shall at all times afford the Authorized Representatives every reasonable, safe, and proper facility for inspecting the Work at the Site. The observation and inspection of any Work shall not relieve the Contractor of any of his obligations to perform proper and satisfactory Work as herein specified. If at any time an inspection, test, or analysis of Work reveals faulty design, inferior, or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, such Work will be rejected and shall be replaced with satisfactory Work at the Contractor's expense. Finished or unfinished Work found not to be in strict accordance with the Contract shall be replaced as directed, even though such Work may have been previously approved and payment made therefore.

B. Removal of Rejected Work and Materials: The Owner or its Authorized Representatives shall have the right to reject materials and workmanship which are defective or require correction. Rejected Work and materials must be promptly removed from the Site, which must at all times be kept in a reasonably clean and neat condition.

C. Failure to Reject Inferior Work and Materials: Failure or neglect on the part of the Owner or its Authorized Representatives to condemn or reject bad or inferior Work or materials shall not imply an acceptance of such Work or materials. Nor shall it be construed as barring the Owner or its Authorized Representatives at any subsequent time from recovering damages or a sum of money needed to build anew all portions of the Work in which inferior workmanship or improper materials were used.

D. Examination of Completed Work: Should it be considered necessary or advisable by the Owner or its Authorized Representatives at any time before final acceptance of the Work to make examinations of portions already completed, by removing or tearing out all or portions of such Work, the Contractor shall, on request promptly furnish all necessary facilities, labor, and material for that purpose. If such Work is found to be defective in any respect, the Contractor shall defray all expenses of such examination and of satisfactory reconstruction. If, however, such Work is found to meet the requirements of the Contract, the cost of examination and

restoration of the Work shall be considered an item of Extra Work to be paid for in accordance with the provisions of these Contract Documents.

E. Proper Operation of Equipment during Tests or Training: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner accepts the Work and issues a Certificate of Beneficial Use.

1.04 INSPECTION OF MATERIALS

A. Inspection During Manufacture, Preparation or Testing: Where required by the Contract Documents, the Contractor shall give notice in writing to the Engineer sufficiently in advance of his intention to commence the manufacture or preparation of materials especially manufactured or prepared for use in or as part of the permanent construction. Such notice shall contain a request for inspection, the date of commencement, and the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, the Engineer will arrange to have a representative present at such times during the manufacture or testing as may be necessary to inspect the materials, or he will notify the Contractor that the inspection will be made at a point other than the point of manufacture or testing, or he will notify the Contractor that the inspection will be waived. The Contractor must comply with these provisions before shipping any materials. Such inspection will not release the Contractor from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

B. Testing Electrical and Mechanical Equipment: Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized test codes of the ANSI, ASME, or IEEE, except as may otherwise be stated herein.

1.05 COSTS OF INSPECTION

A. Inspection by the Owner or its Authorized Representatives: All inspection and testing of materials furnished under this Contract will be performed by the Owner or its Authorized Representatives or inspection bureaus without cost to the Contractor, unless otherwise expressly specified. The Contractor shall reimburse the Owner for expenditures incurred in making such tests on materials and equipment which were rejected for noncompliance. Costs of inspections required outside of normal working hours will be paid by the Contractor at a rate of $115/hr for each inspector required. Normal working hours are considered to be a maximum of 10 hours per day, Monday through Saturday.

B. Shop and Field Tests: The cost of shop and field tests of equipment and certain other tests specifically called for in the Contract Documents shall be borne by the Contractor, and such cost shall be deemed to be included in the Contract Sum.

C. Tests for Equivalent Materials and Equipment: Materials and equipment submitted by the Contractor as the equivalent to these specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for expenditures incurred in making such tests on materials and equipment which were rejected for noncompliance.

1.06 FAILURE TO COMPLY WITH CONTRACTS

A. Rejection of Equipment or Material: If it is ascertained by testing or inspection that the material or equipment does not comply with the Contract, the Contractor will be notified and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the Site or from the Work and replace it with acceptable material without cost to the Owner. Failure of the Owner or its Authorized Representatives to ascertain noncompliance or to notify the Contractor of any noncompliance shall not relieve the Contractor from fulfilling his obligations under the terms and conditions of the Contract.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 PREPARATION

A. Equipment and Machinery: The Contractor shall have on hand sufficient proper equipment and machinery of adequate capacity to facilitate the Work and to handle all emergencies normally encountered in Work of this character.

END OF SECTION 01450

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General Requirements

B. Temporary Utilities

C. Temporary Construction

D. Barricades and Enclosures

E. Security

F. Temporary Controls

G. Access and Parking

H. Use of Site for Storage and Field Offices

I. Emergencies

1.02 RELATED SECTIONS

A. Section 02370 Erosion and Sediment Control

1.03 GENERAL REQUIREMENTS

A. Furnish plant and equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the time stipulated in the Bid Form. If at any time such plan appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character or increase the plant equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

B. Contractor to Furnish Temporary Facilities: All false work, scaffolding, ladders, hoistways, braces, pumping plants, shields, trestles, roadways, sheeting, centering forms, barricades, drains, flumes, and the like, any of which may be needed in the construction of any part of the work and which are not herein described or specified in detail, must be furnished, maintained and removed by the Contractor, and he shall be responsible for the safety and efficiency of such works and for any damage that may result from their failure or from their improper construction, maintenance or operation.

C. First Aid: In addition to any other requirements, the Contractor shall maintain a readily accessible, completely equipped first aid kit at each location where work is in progress.

D. Safety Responsibility: The Contractor shall be solely responsible for safety and security at the site. The Contractor will indemnify and hold harmless the Owner and its Authorized Representatives for any safety violation, or noncompliance with governing bodies and their regula-

tions, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by the contractor and while performing any part of the Work.

1.04 TEMPORARY UTILITIES

A. Light and Power: The Contractor shall provide at his own expense temporary lighting and power facilities required for the proper construction and inspection of the Work. If these facilities are inadequate, the Contractor will not be permitted to proceed with any portion of the Work affected thereby. Temporary lighting and power shall be maintained until the Work is accepted. Power must be supplied to the PLC panel for the duration of construction, including nights and weekends. Generators are not an acceptable power source on nights and weekends.

B. Heat: The Contractor shall provide temporary heat, whenever required, for work being performed during cold weather to prevent damage to the Work or existing facilities. The use of open salamanders and other temporary heating devices that cause smoke are not permitted.

C. Sanitary Facilities: The Contractor shall not be allowed to use any of the Owner's existing sanitary facilities or those included in the Work. The Contractor shall furnish and maintain adequate temporary sanitary facilities for his personnel, including all subcontractor personnel, for the duration of the Contract; shall prohibit and prevent nuisances on the site of the Work or on adjoining property; and shall permanently remove from the site any employee who violates this rule. The Contractor shall also abide by all applicable health and environmental regulations and shall obtain all permits required by local code.

D. Connections to Existing Utilities:

1. Unless otherwise specified or indicated, the Contractor shall make all necessary connections to existing facilities including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electricity. In each case, the Contractor shall receive permission from the Owner or the owning utility prior to undertaking connections. The Contractor shall protect facilities against deleterious substances and damage.

2. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously to complete connections in the minimum time. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

1.05 BARRICADES AND ENCLOSURES

A. Protection of Workmen and Public: During the prosecution of the Work, the Contractor shall put up and maintain at all times barriers and lights to prevent accidents. The Contractor shall provide suitable barricades, lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the Work causes obstructions to the normal traffic or constitutes in any way a hazard to Owner's personnel or the public.

B. Barricades and Lights:

1. Streets, Roads and Highways: All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by effective barricades which display acceptable warning signs (meeting VDOT standards). Barricades shall be located at the nearest public highway or street on each side of the blocked section.

2. Excavations and Trenches: All open trenches and other excavations shall have barricades, signs, and lights suitable to provide adequate protection for plant personnel. Obstructions such as material piles and equipment shall be posted with similar warning signs and lights.

3. Statutory Requirements: All barricades, signs, lights, and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, within highway rights-of-way, as required by the authority having jurisdiction there over.

1.06 FENCES

A. Existing Fences: Existing fences affected by the Work shall be maintained by Contractor until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

B. Restoration: On completion of the Work, the Contractor shall restore all fences to their original or better condition and to their original location.

1.07 SECURITY

A. Preservation of Property:

1. The Contractor shall preserve from damage all property along the line of the Work in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. He shall preserve from damage public utilities, trees, lawn areas, building monuments, fences, pipe and underground structures, and public streets. (Normal wear and tear of streets resulting from legitimate use by the Contractor shall not be considered as damage.) Whenever the Contractor damages such property, he shall immediately restore it to its original condition at his own expense.

2. In case of failure on the part of the Contractor to restore such property or make good such damage or injury, the Owner may, upon 24 hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any moneys due or which may become due the Contractor under this Contract. If removal, repair or replacement of public or private property is made necessary by alteration of grade or alignment authorized by the Owner and not contemplated by the Contract Documents, the Contractor shall be compensated, in accordance with the General Conditions provided that such property has not been damaged through fault of the Contractor or his employees.

B. Public Utility Installations and Structures:

1. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, vaults, manholes, and other appurtenances and facilities, whether owned or controlled by public bodies or privately owned individuals, firms or corporations, used to serve the public with transportation, gas, electricity, telephone, storm and sanitary sewers, water, or other public or private utility services. Facilities appurtenant to public or private property which may be affected by the Work shall be deemed included hereunder.

2. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. Existing public utility installations and structures are indicated on the Drawings only to the extent such information was made available to, or discovered by, the Engineer in preparing the Drawings. This data is not guaranteed for completeness or accuracy, and the Contractor is responsible for making his

own investigations to fully inform himself of the character, condition, and extent of all installations and structures that may be encountered and that may affect the construction operations.

3. Further, the Contractor is responsible for enforcing the requirements of Chapter 63, Fairfax County Code Chapter 63, Excavation and Utility Line Installation. In particular, the Contractor is directed to Section 63-2-2, Demolition or Excavation; Prior Notice. The Contractor shall contact VA811 (Miss Utility of Virginia) sufficiently in advance of the start of construction to comply with this requirement.

4. The Contractor must remove, replace, relocate, repair, rebuild, and secure at his expense any public utility installations and structures. The Contractor shall be responsible and liable for any consequential damages done to or suffered by any public utility installations or structures. The Contractor also shall be responsible for any injury, damage, or loss which may result from or be consequent to interference with, or interruption or discontinuance of, any public utility service.

5. Any water, gas, or other service connection damaged during the Work shall be repaired or replaced by the Contractor at his expense, which shall be deemed included in the Contract Price.

6. The Contractor shall, at all times in performance of the Work, employ proven methods and exercise reasonable care and skill to avoid unnecessary delay, injury, damage, or destruction to public utility installations and structures; and shall avoid unnecessary interference with, or interruption of, public utility services; and cooperate fully with the owners thereof to that end.

7. The Contractor shall give written notice to the owners of all public utility installations and structures affected by his proposed construction operations, sufficiently in advance of breaking ground in any area or on any unit of the Work, to obtain their permission before disturbing the lines and to allow them to take measures necessary to protect their interests. The Contractor must advise the Chiefs of Police and the Fairfax County Fire and Rescue Services of any excavation in public streets or the temporary shut-off of any water main. At least 24 hours notice shall be given by the Contractor to all affected property owners whenever service connections are taken out of service.

C. Work on Private Property: Where installations are to be placed on private property, rights-of-way or easements will be secured by the Owner without cost to the Contractor. Where Work is required on private property in order to construct an installation within the rights-of-way, the Contractor shall be responsible, without cost to the Owner, for securing written permission to work on the private property. The Contractor shall conduct his operations along rights-of-way and easements through private property to avoid damage to the property and to minimize interference with its ordinary use. The Contractor shall, upon completion of the Work through such property, restore the surface and all fences or other structures disturbed by his operations as nearly as possible to the conditions in which he found them. No material shall be used or removed from private property without the consent of the Owner or responsible party in charge of such property. The Contractor shall save the Owner harmless from any claim or damage arising out of or in connection with the performance of Work across and through private property.

D. Miscellaneous Structures: The Contractor shall be held entirely responsible for all injuries or damage to culverts, building foundations and walls, retaining walls, or other structures of any kind met with during the prosecution of the Work, and shall be liable for damages to public or private property resulting there from. All pipes carrying liquid shall be adequately protected against freezing.

E. Protection of Trees and Lawn Areas:

1. All trees and shrubs, except those ordered to be removed, shall be adequately protected by boxes or otherwise by the Contractor. No excavated material shall be placed so as to injure such trees or shrubs. Trees or shrubs destroyed by accident or negligence of the Contractor or his employees shall be replaced by him with new stock of similar size and age, at the proper season, and at the Contractor's expense.

2. Lawn areas shall be left in as good condition as before the start of the Work. The areas where sod has been removed shall be restored by seeding or sodding in accordance with the requirements of Section 02920.

E. Site Security

1. The area affected by this project is considered by The Owner to be critical infrastructure and therefore the physical security of this site shall be maintained to the same or greater standard throughout the duration of the work as it was prior to commencement. If Contractor activities diminish, compromise, or alter the site's perimeter controls (e.g. fencing or gates) or other security systems, then the Contractor must develop a physical security plan to be submitted for review by The Owner prior to commencement of work. No work shall commence that effects the security of the site without written permission of The Owner.

2. To the extent possible the Contractor shall use The Owner designated gates and site access roads as the primary entrance and exit from the site. In all cases the Contractor shall ensure that the facility is locked at the end of each workday and when no Contractor personnel are on site. In the event of an emergency or as the Construction activities require additional or alternative access locations the Contractor shall get written approval from The Owner to cut additional openings. No permission will be necessary for emergencies threatening life or safety.

3. Throughout the duration of the work under this contract, the Contractor will be required to inspect all perimeter fencing and gates at least weekly. The fence lines must be kept clear of vegetation and construction materials within 4 feet of a fence line. Construction materials and equipment are not permitted to be stored against the fence or in the manner that which creates a bridge by which someone can easily traverse the fence. All damage must be reported to The Owner's representative. Damaged fences resulting in an opening or a means to gain access to the site constitute an immediate security risk and shall be considered the highest priority for repairs.

4. All personnel gates, vehicle gates, buildings, vaults, tanks, ladder hatches, electrical junctions, and tank hatches shall be kept locked at all times unless a member of the Contractor's staff is manning the normally locked facility or within sight of the facility and in a position to monitor access to it unless specific procedures have been established and approved by The Owner to allow the facility to be left unlocked.

5. At the sole discretion of The Owner, for reasons to secure the identified critical infrastructure, the Contractor may be asked to cease all or portions of the work and to vacate the site. The Contractor shall promptly comply with The Owner's request and will resolve scheduling matters by the provisions outlined in Article 8 of the General Conditions.

6. Key Control: The Owner will control and issue Electronic Keys to the Contractor to secure access to the general site and other locations that require shared access by both The Owner and the Contractor personnel. A reasonable number of keys will be assigned to the Contractor at the beginning of the project in exchange for the acknowledgement that the

use of the keys to The Owner's premises is governed by The Owner's Access Key Control Program. In the event that any key in Contractor's possession is lost or stolen, the Contractor must to report such loss immediately to The Owner's representative. The keys shall remain the sole and exclusive property of The Owner while in the Contractor's possession and shall be returned within one business day of a request. Any direct costs incurred by The Owner to recover keys or to re-key locks to secure the site may be passed on to the Contractor. Deliberate avoidance or non-compliance with the procedures in this section or in The Owner's Key Control Program may result in a revocation of key use privileges.

.

7. Contractor's Identification: All Contractor employees and subcontractors shall have a photo identification card that must be carried by the employee at all times. The identification card must contain the following information: employee photograph, company name, employee name, color coded symbols designating approved work area(s), employee number (matching hardhat), and project name. All Contractor employees without current identification cards will be stopped to verify that the person is authorized to be on site and a Contractor escort will be required from the Contractor. All construction employees must show a valid identification card at the entrance gate and upon request while working on site. The Contractor shall provide and issue these cards to the employees and provide the owner with an up-to-date list of employees on a weekly basis and a monthly log with application for payment.

8. Hart Hat Identification: Each Contractor employee, including subcontractors, must wear a hard hat with proper identification. Each hard hat shall display a distinctive corporate logo to identify the responsible company. The Owner shall be provided a list of all companies and personnel to be assigned work in the area. The Owner will designate the work area color code. Each hard hat must also have lettering/numbering at least 2-inches in height that identifies the specific employees entering authorized construction areas and exclude them from prohibited areas.

9. Deliveries: Contractor deliveries must occur only when The Owner's Representative is on the site. No after-hour deliveries are permitted without Owner approval. Upon arrival, The Owner's Representative will notify the Contactor's representative to verify the delivery (company, type of material and vehicle information/identification). Deliveries may be subjected to a security inspection before the delivered item can enter the building.

10. Contractor's Work Site Security: The Contractor must store all equipment and materials only in those areas designated by the Owner for this purpose. The Owner is neither responsible nor liable for any equipment, materials, or other property of the Contractor. The Contractor may choose, at his expense, to provide additional security elements as desired to adequately protect his assets on the job site.

1.08 TEMPORARY CONTROLS

A. During Construction:

1. Debris Control:

a. During construction of the Work, the Contractor shall at all times keep the site of the Work and adjacent premises as free from materials, debris, and rubbish and shall remove such from any portion of the site if, in the Engineer's opinion, such material, debris, or rubbish constitutes a nuisance or is objectionable.

2. Remove Surplus Materials: The Contractor shall remove from the site all these surplus materials and temporary structures when they are no longer needed.

3. Construction Materials: Construction materials such as concrete forms and scaffolding shall be neatly stacked by the Contractor when not in use. The Contractor shall promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

4. Volatile Wastes: Volatile wastes shall be properly stored in covered metal containers and removed daily.

5. Waste Disposal: Wastes shall not be buried or burned on the site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the site and disposed of in a manner complying with local ordinances and antipollution laws.

B. Smoke Prevention:

1. The Contractor shall strictly observe all air pollution control regulations.

2. No open fires will be permitted on site.

C. Noises:

1. Acceptable Noise Levels: The Contractor shall be responsible for maintaining acceptable noise levels in the vicinity of the Work and compliance with the Code of the County of Fairfax, Chapter 108during the performance of the Work under this Contract. The Contractor shall limit noise production to acceptable levels by using special mufflers, barriers, enclosures, equipment positioning, and other approved methods.

2. Variance Requirements: The Contractor shall supply written notification to the Owner sufficiently in advance of the start of any Work which violates this provision and shall not proceed until the Contractor obtains all applicable authorizations, including a variance from the County of Fairfax and the Owner's written consent.

D. Hours of Operation:

1. The Contractor shall keep the Engineer informed regarding his hours of operation and work activities. The Contractor shall submit his normal working hours to the Engineer prior to starting any work in the field. Whenever the Contractor works outside his normal working hours, adequate advance notice shall be provided to the Engineer.

2. The Code of the County of Fairfax, Chapter 108, specifically prohibits the operation of construction equipment between the hours of 9:00 P.M. and 7:00 A.M. on Sunday through Thursday; or Between 9:00 P.M. and 9:00 A.M. on Friday, Saturday, or the day before a Federal Holiday. The Contractor shall supply written notification to the Owner sufficiently in advance of the start of any work which violates this provision and shall not proceed until a variance has been obtained from Fairfax County allowing for night operations and until he has the written consent of the Owner.

3. No non-emergency Work, including equipment moves, shall be performed on Sundays without prior authorization by the Owner.

E. Dust Control:

1. The Contractor shall take measures to prevent unnecessary dust. Earth surfaces exposed to dusting shall be kept moist with water or by application of a chemical dust suppressant. Materials in piles or in transit shall be covered to prevent blowing or spreading dust.

2. Buildings or operating facilities which may be affected adversely by dust shall be adequately protected. Machinery, motors, instrument panels, or similar equipment shall be protected by suitable dust screens. Proper ventilation shall be included with dust screens.

3. Sweep and wash all paved roads daily.

4. Sweep and wash all paved roads used for hauling roads twice daily.

5. Provide wheel wash facility at locations adjacent to paved roads. All vehicles leaving unpaved roads must use the wheel wash facility before using the paved roads.

F. Water Control

1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, or adjoining properties. Control fill, grading and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses so as to prevent any erosion, damage or nuisance.
2. Provide, operate and maintain equipment and facilities of adequate size to control surface water.
3. Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the Site or to adjoining areas and in conformance with all environmental requirements.

G. Pollution Control

1. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations.
2. Provide equipment and personnel, perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids. Excavate and dispose of any contaminated earth offsite, and replace with suitable compacted fill and/or topsoil.
3. Take special measures to prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.
4. Provide systems for control of atmospheric pollutants, prevent toxic concentrations of chemicals, and prevent harmful dispersal of pollutants into the atmosphere.
5. All Contractors' equipment used during construction shall conform to all current federal, state and local laws and regulations.

1.09 ACCESS AND PARKING

A. Access:

1. Access to the site of the work shall be restricted to existing public roads and to roads and easements owned by the Owner.

2. The Contractor shall construct and maintain all access of haul roads, except where noted, necessary for equipment and material movement.

3. The Contractor shall provide and maintain suitable parking areas for the use of all construction workers and others performing Work or furnishing services in connection with the Contract, to avoid any need for parking personal vehicles where they may interfere

with public traffic or construction activities.

4. Maintenance of Traffic: The Contractor shall conduct his work in such a manner as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, parking spaces and walks, whether public or private, the Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private parking and drives before interfering with them. Such maintenance of traffic will not be required when the Contractor has obtained permission from the owner and tenant of private property, or from the Owner having jurisdiction over the public property involved, to obstruct traffic at the designated point.

1.10 USE OF SITE FOR STORAGE AND FIELD OFFICES

A. Requirements:

1. The Contractor shall be responsible for obtaining off- site locations for storage of equipment and materials, at no additional cost to the Owner. No on-site storage will be allowed other than current materials and equipment being utilized immediately.

2. Any structures or facilities needed for storage or field office shall be constructed by the Contractor at his own expense and no separate payment will be made therefor.

3. All security requirements for such facilities shall be provided and maintained by the Contractor.

4. Space on the site for storage and materials, spoil, construction offices, and the like, is limited. The Contractor shall submit his requests and proposed layouts for space allocations to the Engineer for review. The Contractor is limited to the area shown as limits of work on the site plan.

5. The Contractor shall confine his use of the site to the areas designated by the Engineer.

6. Whenever the Engineer determines that the use of the site by the Contractor is detrimental to the overall performance of the work under the several Contracts, or interferes with the operation of the facility, and notwithstanding prior allocation or approval by the Engineer, the Engineer may order the Contractor to relocate his materials, equipment, temporary plants, and the like, and the Contractor shall comply with the directive of the Engineer. No additional compensation or extension of Contract time will be allowed for any such relocation of materials, equipment, temporary plant, or the like.

7. Nothing contained herein or shown on the Drawings shall be interpreted as giving any Contractor exclusive occupancy of the areas on the site provided for his operations. Owner personnel, for any purpose, and other contractors of the Owner, for any purpose required by their respective Contracts, may enter upon or occupy portions of it, as directed or permitted by the Engineer. The Contractor shall conduct his work so as to prevent interference with the work of the Owner or other Contractors.

8. Upon completion of the work and as directed by the Engineer, the Contractor shall clean up the areas, remove any temporary facilities, finish grade and return the areas to previous existing conditions as necessary all to the satisfaction of the Engineer.

B. Contractor's Field Offices:

1. The Contractor shall furnish, equip, and maintain a secure location on-site of a size required

for his operations. Any structure or facility, if needed, shall be constructed by the Contractor at his own expense and no separate payment will be made therefore. The Contractor shall be responsible for the selection and authorization, in writing, for the field structure or facility site. The size and location of any facility shall require the Owner's approval. The Contractor shall provide at his option his own telephone service. Readily accessible copies of both the Contract Documents and the latest approved shop drawings shall be kept at this location.

1.11 EMERGENCIES

A. The Contractor shall at all times, before and after regular working hours including weekends and holidays, maintain a telephone number where he or his representative can be reached on an emergency basis. The Contractor or his representative shall be prepared to act to correct conditions on site that are deemed to constitute an emergency by the Owner, his agent, the Engineer, or local authorities and is obligated to act to prevent threatened damage, injury or loss without special instructions from the Owner or Engineer. The Contractor shall give the Engineer prompt written notice of all significant changes in the work or deviations from the Contract Documents caused thereby. If a condition on the site requires attention after hours, either the Owner, his agent, the Engineer, or local Authorities shall call the Contractor or his representative at the emergency telephone number, identify himself and describe the emergency condition. The Contractor is expected to dispatch personnel and equipment to adequately institute corrective measures within 2 hours. If for any reason the Contractor or his agent cannot be reached at the emergency number after a reasonable amount of time (not exceeding 30 minutes), the Owner reserves the right to initiate corrective measures and the costs shall be deducted from payments due to the Contractor.

B. In the event that the Contractor fails to maintain safe job conditions and traffic conditions, including but not limited to trench settlement and storage of hazardous backfill or construction materials, the Owner, after failure of the Contractor to commence substantial steps at the job site to rectify the situation within 2 hours of the time the Contractor has been notified of the unsafe condition, may hire guards, take such precautions, make such repairs, and take any other steps which the Owner or the Owner's agent in its discretion considers necessary to protect the property, persons or Owner. The costs for such actions shall be deducted from payments due to the Contractor.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01500

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the Work:

1. Conform to applicable specifications and standards.

2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.

3. Manufactured and Fabricated Products:

a. Design, fabricate and assemble in accord with the best engineering and shop practices.

b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.

c. Two or more items of the same kind shall be identical, by the same manufacturer.

d. Products shall be suitable for service conditions.

e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.

4. Do not use material or equipment for any purpose other than that for which it is designed or is specified.

1.02 RELATED REQUIREMENTS

A. Conditions of the Contract.

B. Summary of Work is included in Section 01110.

C. Shop Drawings, Working Drawings, Product Data and Samples are included in Section 01330.

D. Substitutions and Product Options are included in Section 01630.

E. Cleaning is included in Section 01710.

F. Operating and Maintenance Data is included in Section 01782.

G. Warranties and Bonds are included in the General Conditions, Division 0.

1.03 APPROVAL OF MATERIALS

A. Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the work without prior approval of the Engineer.

B. Within 30 days after the effective date of the Agreement, or in strict compliance with the submittal schedule approved as specified in Section 01330, the Contractor shall submit to the Engineer, data relating to materials and equipment he/she proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications. The data shall comply with Section 01330.

C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit samples of materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.

D. The Contractor shall submit data and samples sufficiently early to permit consideration and approval before materials are necessary for incorporation in the work. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of claim against the Owner or the Engineer.

E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.

F. The materials and equipment used on the work shall correspond to the approved samples or other data.

1.04 MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including five copies to the Engineer.

1. Maintain one set of complete instructions at the job site during installation and until final acceptance.

B. Handle, install, connect, clean, condition and adjust products in strict accord with such instructions and in conformity with specified requirements.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.

2. Do not proceed with work without clear instructions.

C. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.05 STORAGE AND HANDLING OF EQUIPMENT ON SITE

A. Because of the long period allowed for construction, special attention shall be given to the storage and handling of equipment on site. As a minimum, the procedure outlined below shall be followed.

1. Equipment shall not be shipped until approved by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under

no circumstances shall equipment be delivered to the site more than three months prior to installation without written authorization from the Engineer. Operation and maintenance data as described in Section 01782 shall be submitted to the Engineer for review prior to shipment of equipment.

2. All equipment shall be stored fully lubricated with oil, grease, etc, unless otherwise instructed by the manufacturer.

3. A copy of the manufacturer's storage instructions shall be given to the Engineer and shall be carefully studied by the Contractor and reviewed with the Engineer by him. These instructions shall be carefully followed and a written record of this kept by the Contractor.

4. Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.

5. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work, if stored for longer than ninety days, shall have the bearings cleaned, flushed and lubricated prior to testing and startup, at no extra cost to the Owner.

6. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

7. Contractor shall store his equipment and materials at the job site in accordance with the requirements of the General Conditions, the Supplemental Conditions, and as hereinafter specified. All equipment and materials shall be stored in accordance with manufacturer’s recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations and rulings of the public authority having jurisdiction. The Contractor shall provide a temporary storage building for storage of all major equipment items to be stored on site prior to incorporation into the Work. Provision shall be made for electric service to power space or strip heaters as necessary. Where space or strip heaters are provided within the enclosure for motors, valve operators, motor starters, panels, instruments, or other electrical equipment, the Contractor shall make connections to these heaters from an appropriate power source and operate the heaters with temperature control as necessary until the equipment is installed and being operated according to its intended use. Where space heaters are not provided but temperature and/or humidity control are recommended by the equipment manufacturer, and for all electric panels, Contractor shall provide temporary heat as required to meet the requirements as directed by the Engineer.

8. The Contractor shall maintain an equipment storage rotation log for all equipment provided. Rotation log shall include, as a minimum, the equipment identification, date stored, date removed from storage, copy of manufacturer’s recommended storage guidelines, date of rotation of equipment, and signature of party performing rotation. Moving parts shall be rotated a minimum of once weekly. Contractor shall submit a copy of the rotation log to the Engineer at each monthly progress meeting. Failure to properly maintain stored materials is sufficient cause for rejection of the equipment by the Owner.

9. Contractor shall enforce the instructions of Owner and Engineer regarding the posting of regulatory signs for loadings on structures, fire safety, and smoking areas.

10. Contractor shall not store unnecessary materials or equipment on the job site, and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

11. Materials shall not be placed within 30 feet of fire hydrants or no closer than allowed by local codes. Gutters, drainage channels and inlets shall be kept unobstructed at all times.

12. Stored materials shall not encroach upon private property without written agreement that storage on their property is acceptable.

13. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specific conditions and free from damage or deterioration.

14. Protection after Installation

    a. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove covering when no longer needed.

15. The Contractor shall be responsible for all material, equipment and supplies sold and delivered to the Owner under this contract until final inspection of the work and acceptance thereof by the Owner. In the event any such material, equipment and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace some without additional cost to the Owner.

16. Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract within seven days after written notice to do so has been given, the Owner retains the right to correct all deficiencies noted in previously transmitted written notice and deduct the cost associated with these corrections from the Contractor's contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01600

SECTION 01615

BUILDING, WIRE, AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.1 SCOPE

A. This section covers the equipment identification system established by the Owner and the Engineer to provide consistent designation for all equipment items, valves, electrical and instrumentation control devices and equipment, panels, and other similar items identified in the Contract Documents. An identification number or designation shall be provided on a nameplate or tag for each equipment item, valve, device, panel, or other similar item as specified or as indicated in the equipment symbols in the Contract Documents. Where no identification number of designation is provided in the specifications or on Drawings, the Engineer will provide the designation in accordance with the equipment identification numbering system defined herein.

1.2 GENERAL

A. All electrical wiring, control wiring, equipment items, valves, devices, panels, and other similar items specified or indicated on Drawings shall be provided with a permanent identification nameplate or tag. Electrical and control wiring shall be provided with permanent unique identification tags at terminations, which match identification in as-built drawings and/or approved respective submittal(s). Except as otherwise specified, the identification number shall be stamped or engraved on a stainless steel or anodized aluminum nameplate or tag, or engraved on a laminated plastic nameplate or tag, at the option of and as acceptable to the Engineer.

1.3 ELECTRICAL AND CONTROL WIRING IDENTIFICATION

A. Wires shall be identified with permanent unique tags at terminations. Tags shall be constructed of PVC, yellow or white, with legible machine-printed black markings, as manufactured by Raychem Type D-SCE or ZH-SCE, or Brady Type 3PS. Tags shall match identification in project as-built drawings and/or approved respective submittal(s).

B. Provide wiring types, color coding, and other identification requirements as specified in Section 16070.

1.4 SUBMITTALS

A. List of SAP Number, Asset Management Identifier, nameplates and sample tags before production for Owner approval.

B. Equipment Index, as shown in Table 01615A and described herein.

1.5 NAMEPLATES AND TAGS

A. Equipment and valves shall be identified with tags only when the item is too small to accommodate the specified nameplates. Identification used shall be the same as the designation indicated in the specifications or on Drawings. Nameplates and tags shall be located in a conspicuous place acceptable to the Engineer.

B. Plastic nameplates shall be laminated in phenolic resin not less than 1/8 inch thick and shall

be black with white core. Letters and numbers shall be at least 3/16 inch high extending through the black face into the white layer.

C. Metal nameplates and tags shall be stainless steel or anodized aluminum not less than 12 gage thickness and shall have black enamel background. Letters and numbers shall be 1 inch high with machine produced font engraved or imprinted thereon.

D. Tags shall have smooth edges and shall have a minimum diameter of 2 inches. Letters and numbers shall be machine produced font at least 1 inch high.

E. Nameplates shall be installed with corrosion-resistant mechanical fasteners. Tags shall be installed with corrosion-resistant chains or straps.

F. Nameplates and tags shall not be painted over.

G. All Equipment shall be labeled with the SAP Number and Asset Management Identifier on separate nameplates or tags.

1.6 EQUIPMENT IDENTIFICATION LABELING SYSTEM

A. Each equipment item, valve, device, panel, and other similar item that is specified or indicated on the drawings shall have a SAP Number and Asset Management Identifier as shown on Table 01615A.

1.7 EQUIPMENT INDEX

A. Complete Table 01615A, Equipment Index, and provide to the Owner as an Excel file.

B. Identify equipment by the Asset Management Identifier provided in Table 01615A and complete all fields in the Equipment Index with the exception of the SAP No. The Owner will generate the final SAP Numbers during the Construction Phase and provide them to the Contractor.

C. Provide the Equipment Index for all equipment that is on site every 60 days. New items and changes to previous submissions shall be reflected on the Equipment Index. The Owner will provide SAP Numbers for equipment labeling for approved Equipment Indexes. A complete Equipment Index for all applicable equipment shall be provided 60 days prior to the date of Beneficial Use of the Entire project.

1.8 SUPPLEMENTS

A. The following Supplement, following “End of Section,” is part of this Specification:

1. Table 01615A, Equipment Index.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01615

Table 01615A - Equipment Index for New Equipment

SAP# (FW use only)	Asset Management Identifier	Description	Functional Location	Description of Functional Location	Location	Room	Manufacturer	Model #	Manufacturer Part #	Manucturer Serial #	Object Type	Weight	Size/Dimension	Start-up Date	Acquisition Value	Acquisition Date	Customer Begin Warranty	Customer Warranty End	Customer Master Warranty	Vendor/Manufacturer Warranty	Vendor/Manufacturer Warranty End	Vendor/Manufacturer Master Warranty
		Motor 1																				
		Motor 2																				
		Motor 3																				
		Variable Frequency Drive 1																				
		Variable Frequency Drive 2																				
		Soft Start Motor Control																				
		Motor Control Center																				
		Transfer Switch																				
		Switchboard																				
		7.5 Ton Unit (HVAC) 1																				
		7.5 Ton Unit (HVAC) 2																				
		7.5 Ton Unit (HVAC) 3																				

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01630

PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section outlines the policies and procedures for obtaining consideration and acceptance of products other than those specified.

1.02 RELATED SECTIONS

A. Section 01600 Materials and Equipment

1.03 DESIGN REQUIREMENTS

A. Intention of Contract Documents: It is the intention of the Contract Documents to construct the Work with the specified products. The Contractor shall base his bid price on the products specified. The Owner has the right to reject proposed substitutions for any reason.

B. Equivalent Materials and Equipment

1. Whenever a material, article or method is specified or described by using the name of a proprietary product or the name of a particular manufacturer or vendor, followed by the phrase "or equal", the specific item mentioned shall be understood as establishing the type, function, dimension, appearance, and quality desired and is to be the basis upon which bids are to be prepared. Other manufacturer's products or methods not named will be considered as substitutions provided required information is submitted in the manner set forth herein and provided substitution will not require design revisions or revisions of the Contract Documents. This applies to specific construction methods when such are required by the Contract Documents.

2. Whenever a material, article, or method is specified or described without the phrase "or equal", no substitutions will be allowed.

1.04 SUBMITTALS

A. Substitution Requests: For a period of 90 Days after issuance of a Notice to Proceed, the Engineer will consider written requests from the Contractor for substitution or equivalence of products other than those specified. The Contractor shall submit a separate request for each product, supported with complete data, drawings, and samples as appropriate, including but not limited to the following information:

1. A detailed description of the Contractor’s proposed substitution with comparison to product specified, including supplementary or revised Drawings and Specifications, as applicable.

2. A statement of the reason for the proposed substitution and an explanation as to why implementation of such substitution would benefit the Project.

3. A statement of the impact of the proposed substitution, if any, on the Contract Period and/or the Contract Sum.

4. Cost data comparing the proposed substitution with the product specified and the amount of credit that the Contractor proposes to issue to the Owner if the proposed substitution is accepted.

5. Any required license fees or royalties.

6. Availability of maintenance service and source of replacement parts and materials.

7. Such supporting documentation as may be necessary under the circumstances to permit the Owner to evaluate fully the information set forth in 1 through 6 above.

B. Contractor to Submit Requests for Substitutions: Requests for review of a substitution or equivalence will not be accepted from anyone except the Contractor. Moreover, such requests will not be considered until after the issuance of the Notice to Proceed.

C. No substitution will be accepted for any product to be furnished under this Contract unless the manufacturer is, in the Engineer's opinion, of good reputation and has a plant of ample capacity. The manufacturer shall, upon the Engineer's request, be required to submit evidence that he has manufactured a product like the one specified that has been previously used for a like purpose and for a sufficient length of time to demonstrate its satisfactory performance.

D. In no case shall the Owner’s acceptance of a substitution be considered as grounds for a contract time extension or delay claim by the Contractor.

1.05 QUALITY ASSURANCE

A. Contractor Certification: By the submittal of a substitution request, the Contractor shall represent that:

1. He has investigated the proposed substitute product and determined that it is equal to or superior in all respects to the product specified;

2. He shall provide the same warranties or bonds for the substitutions as for the specified products;

3. He shall coordinate the installation of an accepted substitution into the Work and make such other changes as may be required to make the Work complete in all respects;

4. He shall waive all claims for additional costs due to the substitution which may subsequently become apparent. He also agrees to hold the Owner harmless from claims for extra costs and time incurred by other subcontractors and suppliers, or additional services which may have to be performed by the Engineer, for changes or extra work that may, at some later date, be determined to be necessary in order for the Work to function in the manner intended in the Contract Documents.

B. Contractor Responsible for Performance: Neither the acceptance by the Engineer of alternate material or equipment as being equivalent to that specified nor the furnishing of the material or equipment specified shall in any way relieve the Contractor of responsibility for failure of the material or equipment due to faulty design, material, or workmanship, to perform the functions required by the Contract Documents.

C. After approval of a substitution or an equal product, if it is determined that the Contractor submitted defective information or data regarding the product upon which Owner's approval was based, and that unexpected or uncontemplated redesign or rework of the

project will be required in order to accommodate the product, or that the item will not perform or function as well as the specified item for which equal product was requested, the Contractor will be required to furnish the originally specified item; the Contractor shall pay all costs, expenses or damages associated with or related to the unacceptability of such an equal product and the resultant utilization of another item and no time extension shall be granted for any delays associated with or related to such an equal product.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01630

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01710

CLEANING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning, during progress of the Work, and at completion of the Work, as required by General Conditions.

1.02 RELATED REQUIREMENTS

A. General Conditions of the Construction Contract are included in Division 0

B. Each Specification Section: Cleaning for specific Products or work

C. Construction Facilities and Temporary Controls – Section 01500

1.03 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.

C. Wash and shine glazing and mirrors.

D. Polish glossy surfaces to a clear shine.

E. Ventilating Systems:

1. Clean permanent filters and replace disposable filters if units were operated during construction.

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

F. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

G. Prior to final completion, or Owner occupancy, Contractor and Engineer shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire Work is clean.

END OF SECTION 01710

SECTION 01720

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide and pay for field surveying and engineering services required for Project.

1. Survey work required in execution of Project.

2. Civil, structural or other professional engineering services specified, or required to execute Contractor's construction methods.

3. Before any work begins, Contractor shall field verify all existing electrical, instrumentation, and telephone utilities and prepare as-built drawings. This information, and any variations noted during construction, shall be included on the record drawings submitted by the Contractor.

B. Retain the services of a professional land surveyor licensed in the Commonwealth of Virginia to:

1. Identify existing vertical and horizontal control points indicated on the Drawings as required.

2. Verify all existing structure locations and all proposed building corner locations, tank and equipment locations. Verify top of wall and floor elevations of existing structures including invert elevations for existing sanitary and storm manholes and drainage inlets. Verify existing electrical, instrumentation and telephone utilities. This information and any variations noted during construction shall be incorporated on the Record Drawings.

3. Maintain accurate, up-to-date Record Drawings of all underground utilities installed as a part of this Contract and existing utilities located during the Work. Maintain accurate location of all utilities such as piping, duct banks and conduits at the Work progresses.

a. Piping horizontal locations shall include coordinates for all fittings and valves as well as invert elevations for gravity systems and centerline elevations for pressure systems.

b. Ductbank and conduit horizontal locations shall include coordinates for all turns and bends and cross sectional dimensions at 50-foot intervals as well as top elevations.

4. Locate unmapped utilities and other features uncovered during the course of the Work and inform the Engineer immediately of potential conflicts. DO NOT disturb unmapped utilities until the nature and status of the utility has been verified.

5. After completion of construction and before Final Acceptance, prepare and submit a certified survey of the completed work, including a topographical survey of the completed grading and site work and location of all structures, pavement, piping and other improvements.

C. Contractor to provide Record Drawings in accordance with Section 01780.

1.02 RELATED WORK

A. General Conditions are included in Section 00700.

B. Summary of Work is included in Section 01110.

C. Applications for Payment are included in Section 01290.

D. Project Record Documents are included in Section 01780.

1.03 SUBMITTALS

A. Submit to the Engineer, within five (5) working days of receipt of the Notice to Proceed, the complete name and address of professional land surveyor and professional engineers proposed for participation in the execution of this Contract.

B. Submit to the Engineer, within fifteen (15) working days of receipt of the Notice to Proceed, and before beginning any structural excavation, certification signed by the professional land surveyor identified in 1.03A above, verifying the accuracy of the design elevations. Notify the Engineer immediately of any discrepancy between design elevations and actual field elevations.

C. All surveys shall be tied to Commonwealth of Virginia State Plane Grid System. Vertical Control shall be tied to National Geodetic Vertical Datum of 1929 (NGVD 29). Elevations are feet above mean sea level.

D. At the end of the project and prior to final payment, the Contractor shall conduct a survey and submit certified drawings with the Surveyor's title block (signed and sealed by the registered land surveyor identified in Paragraph 1.03A above) of the item's listed below:

1. Certified site survey at 1 inch = 50 ft scale or larger but not greater than 1 inch 20 ft scale, indicating the building corners, sidewalks, paved areas and location of all above-ground structures. The site survey shall include both new and existing facilities and shall be conducted from a common horizontal control point. These drawings shall be included with, and made a part of, the project record documents.

2. Certified topographical surveys at 1 inch = 50 ft scale or larger but not greater than 1 inch = 20-ft with 1 foot contour intervals. The certified topographical site survey shall be in accordance with national map accuracy standards for the scale selected.

3. Contractor shall submit computer generated drawing files in AutoCAD 2008 or later format on CD-ROM. All entries shall be placed on layers named to describe the entity being mapped. All elevation information in the AutoCAD file shall be in an appropriate three-dimensional format.

4. Provide top and bottom structure elevations, pipe invert(s) and rim elevations on manholes and all structures and buildings.

E. Survey shall include all the requirements as outlined in Paragraph 1.06 below.

1.04 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. Registered professional engineer or professional land surveyor of the discipline required for the specific service on the Project, currently licensed in the State.

B. Locate and protect control points prior to starting site work and preserve all permanent reference points during construction.

1. Make no changes or relocations without prior written notice to the Engineer.

2. Report to the Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

3. Require surveyor to correctly replace project control points which may be lost or destroyed.

a. Establish replacements based on original survey control.

1.05 PROJECT SURVEY REQUIREMENTS

A. Establish a minimum of two permanent bench marks on site, referenced to data established by survey control points. Record locations, with horizontal and vertical data, on Project Record Documents.

B. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:

1. Site improvements

a. Stakes for grading, fill and topsoil placement.

b. Utility slopes and invert elevations.

2. Batter boards for structures.

3. Building foundation, column locations and floor levels.

4. Controlling lines and levels required for mechanical and electrical trades.

a. From time to time, verify layouts by same methods.

b. Establish all lines and grades prior to construction of line work for all force mains and sewers at 100-ft increments and at defined breaks in grade.

c. Survey stake and flag the limits of construction and clearing prior to any construction and clearing.

1.06 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. Update the Project Record Drawings on a monthly basis based on the work performed during the month ending at the pay request as a condition for approval of monthly progress payment requests. The Engineer will check the Record Drawings monthly. Complete accurate updating is a condition precedent to approving and processing of monthly pay applications.

C. Maintain an accurate record of all changes, revisions and modifications.

D. Locate by survey the horizontal and vertical locations of all buried pipe and structures exposed during the work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01720

SECTION 01770

BENEFICIAL USE, CONTRACT CLOSEOUT, AND WARRANTY PERFORMANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes the procedures to be followed when closing out the contract.

1.02 FINAL FIELD TESTS

A. Requirements: Upon completion of the Work and prior to final payment, the Contractor shall furnish all labor, materials, and instruments and shall make field tests of equipment as specified to prove compliance with the Contract Documents. If the field tests disclose that any equipment furnished by the Contractor under this Contract does not comply with the requirements of the Contract Documents, the Contractor shall make all changes, adjustments, and replacements required, and repeat the field tests until compliance with those requirements is demonstrated.

1.03 SUBMITTALS

A. Manufacturer's Certificates: Manufacturer's certificates confirming that materials and equipment have been properly installed and are ready to be placed in service shall be submitted by the Contractor prior to Beneficial Use. If material stored on site, also refer to Equipment Manufacturer’s Certification of Installation Testing and Instruction in Section 01600.

B. Operation and Maintenance Data: All operation and maintenance manuals and data required for proper operation and maintenance of equipment and all required training of Owner personnel shall be completed prior to Beneficial Use.

C. Project Record Documents: Project record documents required by the individual specification Sections shall be submitted within 14 days of the date of the Notice of Completion for Beneficial Use.

D. Equipment Index: Equipment Index shall be submitted 30 days prior to Beneficial Use in accordance with Section 01615.

E. Paragraphs A, B, C, and D preceding are considered requirements for Beneficial Use.

1.04 BENEFICIAL USE

A. Notification: When the Contractor considers the Work ready for Beneficial Use, the Contractor shall so notify the Engineer in writing.

B. Inspection: After the Contractor's notification, the Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If the Engineer does not consider the Work complete for Beneficial Use, the Engineer shall notify the Contractor in writing giving reasons therefor. If the Engineer considers the Work complete for Beneficial Use, he shall prepare and deliver to the Owner and Contractor a Notice of Completion for Beneficial Use fixing the date of Beneficial Use, and stating the responsibilities between the Owner and Contractor for operation, heating, utilities, and maintenance. The Notice shall include a list of items to be completed or corrected before final acceptance.

1.05 RELEASING COMPLETED WORK FOR USE

A. Unless otherwise specified, it is the intent of these Specifications that all newly constructed Work be placed in use, when inspected and accepted and placed in service for its intended use. The Contractor shall arrange his operations to permit access to all such parts of the Work by the Owner and other contractors for the Owner.

B. Taking over of parts of the Work for operation before completion of the entire Contract shall not relieve the Contractor of any responsibility for proper integrated operations of all parts of the Work, nor shall it act to relieve him of any responsibilities under the Contract except as follows:

1. When parts of the Work are accepted by the Owner or Engineer in advance of the date of Beneficial Use for the entire Project and such Work is taken over for use by the Owner, the starting date for the warranty period shall be the date for that portion of the Work accepted for Beneficial Use by the Owner.

2. The Engineer will issue certificates describing the Work which is taken over for use by the Owner and the Contractor shall furnish all maintenance and warranty information of manufacturers or suppliers that is applicable to the Work being taken over for use.

1.06 FINAL CLEANING

A. Removal of Contractor's Materials: At the conclusion of the Work, all erection plant, tools, temporary structures and materials belonging to the Contractor shall be promptly taken away and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.

B. Cleaning Materials and Equipment: The Contractor shall thoroughly clean all materials installed by him and existing structures, materials or equipment soiled by the contractor during construction and shall deliver over such materials and equipment undamaged in a bright, clean and polished condition.

1.07 FINAL INSPECTION

A. When the Work has been completed in accordance with the requirements of the Contract and final cleaning has been performed, the Contractor shall request a final inspection which shall be performed by the Engineer within 10 days after receipt of the request. The Work will be deemed complete as of the date set by the Contractor if, upon inspection, the Engineer determines that no further Work remains to be done at the site. Upon determination that all Work is completed, the Engineer will issue a certificate of final completion.

B. However, if such inspection, in the opinion of the Engineer, reveals items of Work still to be performed, the Contractor shall promptly perform them and then request a reinspection. In the event the Engineer then determines that the Work is complete, the date of final completion shall be deemed to be the last day of such reinspection.

C. When the Engineer finds that the Work is acceptable under the Contract Documents, he shall request the Contractor to make closeout submittals.

1.08 REINSPECTION FEES

A. Should the Engineer perform reinspections due to failure of the Work to comply with the claims of status of completion made by the Contractor, Owner will be reimbursed for such inspection by the contractor.

1.09 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Submit evidence of compliance with requirements of governing authorities, including documentation that all permit conditions and closure requirements have been satisfied.

B. Submit evidence of payment and release of liens: Requirements of General Conditions.

1.10 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the Contract amount:

1. The original Contract amount.

2. Additions and deductions resulting from:

a. Change Orders.

b. Units installed and unit prices.

c. Deductions for uncorrected or incomplete Work.

d. Deductions for liquidated damages.

e. Deductions for reinspection payments.

f. Other adjustments.

g. Extended engineering and/or inspection services and inspection overtime.

h. Excessive shop drawings review cost by the engineer.

3. Total Contract amount as adjusted.

4. Previous payments.

5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.11 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the above final contract value in accordance with procedures and requirements stated in the General Conditions.

1.12 WARRANTY PERFORMANCE

A. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Owner will have the work performed by others, and after completion of the work, will charge any remaining contract funds for expenses incurred by the Owner while performing the work, including, but not limited to administrative expenses. In the event

sufficient funds are not available to cover the construction warranty work performed by the Owner at the Contractor's expense, the Owner will have the right to recoup expenses from the Contractor's Surety under the performance bond or warranty/maintenance bond.

B. Following oral or written notification of the required construction warranty repair work, the Contractor shall respond within one working day of his intentions/actions in pursuit of the warranty repair. Failure of the Contractor to respond will be cause for the Owner to proceed against the Contractor as noted in 1.12.A.

C. Warranty Repair Priority

1. The nature of the warranty issue and its impact on operations will be evaluated by the Owner and a Response Priority assigned to the notice as followings:
   a. First Priority Code 1 – Contractor to provide on-site inspection to evaluate the situation and determine the course of action within four (4) hours, initiate the work within six (6) hours and work continuously to completion or relief.
   b. Second Priority Code 2 – Perform on-site inspection to evaluate the situation and determine the course of action within eight (8) hours, initiate the work within 24 hours and work continuously to completion or relief
   c. Third Priority Code 3 – Necessary work to be initiated within three working days and work performed during standard work hours each subsequent day to completion or relief.

D. Contractor's Response to Construction Warranty Requirements

1. Following the oral or written notification by the Owner, the Contractor shall respond to construction warranty service requirements in accordance with the assigned Response Priority code. The Contractor shall submit a report within seven (7) calendar days after completion of activities on any warranty item that has been repaired during the warranty period. The report shall include:
   a. The cause of the problem
   b. The date/time reported
   c. The assigned Response Priority Code
   d. Corrective action taken
   e. When repairs were completed

E. If the Contractor does not perform the construction warranty items within the time frames specified above, the Owner retains the right to perform the work and recover all costs from the Contractor or its surety.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

END OF SECTION 01770

SECTION 01780

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, and data necessary to maintain and produce Project Record Documents (drawings and specifications) in accordance with applicable Contract provisions.

B. Impacts resulting from the Contractor's failure to meet Project Record Documents requirements shall in no part become the subject of a claim for extension of time or for excess costs or damages by the Contractor.

C. The terms 'drawings", "contract drawings", "record documents", "working as-built", and "as-built drawings" all refer to contract drawings which are revised and used for final Project Record Documents.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store working drawings, submittals, shop drawings, and samples in field office apart from documents used for construction.

B. File all documents and samples in accordance with CSI/CSC format.

C. Maintain all documents in a clean, dry, legible condition and in good order. Do not use the Record Documents for construction purposes.

D. Make all documents and samples available at all times for inspection by the Engineer.

1.03 SUBMITTAL

A. Prior to the date of Beneficial Use, submit 2 sets of red-lined final Project Record Documents to the Engineer for review and approval. This submittal is one of the prerequisites to Beneficial Use.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 Record Documents Posting During Construction – Working As-Built

A. The Contractor shall maintain 2 sets of contract drawings and revise by red-line editing to track changes and show the as-built conditions during the execution of the project for each project discipline including, when applicable, Civil, Architectural, Structural, Mechanical, Plumbing, Electrical, Instrumentation / Controls, and special construction. These working as-built documents shall be kept current and updated on a weekly basis and at least one set shall be available for review at the jobsite at all times. Changes from the contract documents which are made in the work, field changes, and additional information uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes on the drawings. The working record documents will be jointly reviewed for accuracy and completeness by the Owner/Engineer and the Contractor prior to submission of each of the Contractor's monthly Applications for Payment.

B. The Contractor shall maintain 2 sets of contract Technical Specifications and revise by red-line editing to accurately reflect all changes to the specifications that occur during the performance of the contract as the result of Addenda, Request for Clarification, Change Orders, and all other written directives.

C. The working as-built shall be marked up accurately and legibly.

   a. When revisions to drawings are made, make changes to affect related section views, details, legends, profiles, plans and elevation views, schedules, notes and designations. No stapling or taping of source document is allowed.
   b. When changes are required on small-scale drawing details, use large-scale inserts with leaders to the applicable location.
   c. Use written explanation to describe changes when graphic means are not sufficient to completely depict the change conditions.

D. Owner/Engineer's review of record documents is for verifying accuracy and conformance to contract requirements. This review is a condition precedent to the approval and processing of each monthly pay application. Accuracy and completeness of all details in record documents such as dimensions, quantities, installation of equipment or systems remain the responsibility of the Contractor.

3.02 CONTENT

A. The Project Record Document packages shall be submitted as follows:

   1. Project Record Documents - Drawings and Specifications

      a. The Contractor shall submit two paper set of red-lined contract drawings and technical specifications for review and approval of the Engineer. The documents should be marked neatly and accurately to reflect actual civil, architectural, structural, electrical, plumbing, mechanical, instrumentation and controls, fire protection, and special construction final as-built conditions of the project as applicable.

      b. Label each set of plans and specifications "RECORD DOCUMENTS". Have skilled draftsperson transfer all changes, corrections, and entries.

      c. Submission and Approval of final Project Record Documents is one of the pre-requisites to final completion of the project.

      d. Submittal information should include the following as applicable:
         1) Changes or modifications as a result of Addenda, Approved Shop Drawings, Request for Clarifications, Record of Minor Changes, Work Orders, Change Orders, and all other written instructions.
         2) Field changes of installation, dimensions, and details of all project components
         3) Field changes to all water mains, valves, structures, fire hydrants, and related appurtenances, showing horizontal and vertical locations, pipe sizes, material, lengths, and elevations
         4) Pipe manufacturer's Laying Schedule and actual field cut dimensions, lay lengths and rotations necessary to tie into existing pipe/facilities.
         5) Final location and depth of all underground and aboveground utilities and raceways

6) Changes in details of design or additional information obtained from fabrication documents, erection plans, material changes, substitutions, installation plans, and placement details
7) Actual locations of anchors and all joints in concrete
8) Relocations or changes in the orientation of equipment and piping
9) Location of concealed internal utilities and appurtenances referenced to visible and accessible features of structure
10) Layout and schematic drawings of electrical panels, raceways, circuits and wiring complete with field verified labels and numbering
11) Layout and schematic drawings of instrumentation control panels, raceways, and wiring complete with field verified labels and numbering
12) Where contract drawings or specifications present options, only the option selected for construction shall be shown
13) Changes or modifications resulting from the Regulatory and Beneficial Use inspections

2. Site As-Built – Projects with a separate site plan or a site permit issued by the locality require an as-built site plan as outlined below:

a. The Contractor shall submit a site as-built prepared by a licensed Land Surveyor or licensed Professional Engineer to Owner/Engineer for review and approval prior to the date of Beneficial Use.

b. The contractor shall also submit the site as-built to local authorities having jurisdiction for review for conformance with the approved site plan and regulatory approval. The site as-built shall be in accordance with the requirements of the Fairfax County Zoning Ordinance 17-300 or other localities having jurisdiction. The Contractor shall pay any required filing, correction, and resubmission fees at no additional cost to the Owner. The approval of site as-built by local authorities is a prerequisite to Final Completion.

c. The site as-built should minimally include the following:
1) Boundary of the site
2) Locations of all utilities, water mains, storm drainage systems, and sanitary sewer pipes with elevations, inverts, and slopes
3) Dimensional locations of all buildings and structures
4) Location and cross-sectional survey of all stormwater or bio-retention facilities
5) Curb and gutter and/or ditch elevations
6) Survey and record topographic elevations for all paving, sidewalks, stairs, ramps, and entrances to verify conformance with contract requirements.
7) Deed book and page number of any dedication and easements
8) Certification by the Contractor's licensed engineer or surveyor indicating that the as-built conforms with the approved site plan except as shown and that it represents the actual conditions on the site, and bearing his seal and signature
9) Any other regulatory requirements and pertinent information as determined by the Owner/Engineer

B. Engineer's review of project record Documents submittal is not conducted for purpose of determining accuracy and completeness of other details such as dimensions, quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor.

3.03 PAYMENT

A. A separate fixed-price pay line item with a designated value is provided for in the Bid Form, Section 00400, Part B, for the Project Record Documents updates and final submissions as outlined herein. This Project Record Documents pay item is not an allowance and the contractor must account for the designated value noted in the bid form in its total base bid price for the project and reflected as such in the schedule of value. The Payment for Project Record Documents will be made as follows:

1. Initial 50% of the pay line item amount shall be divided equally for the duration of the Contract Time and will be paid monthly on the contractor's pay request subsequent to review and approval of working as-built documents by the Owner/Engineer. Failure to obtain this approval will result in rejection of the payment for the Project Record Document pay line item.
2. Final 50% of the Project Record Document pay line item will be paid at final completion upon review and Engineer's approval of the final Project Record Documents including any regulatory review and approval.
3. In the event that the interim working as-built or the final Project Record Documents submittal are found to be incomplete and rejected by the Engineer due to inaccuracies, incomplete information, or other non-conformance issues, the Owner reserves its right to hire an outside engineering firm to field-verify all as-built information and revise the Project Record Documents as required. All costs associated with this effort will be back-charged to the contractor and deducted from the contract amount at final payment.

END OF SECTION 01780

SECTION 01782

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

1.02 RELATED WORK

A. Shop Drawings, Product Data and Samples are included in Section 01330.

B. Project Closeout is included in Section 01770.

C. Project Record Documents are included in Section 01780.

1.03 GENERAL

A. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment Supplier shall prepare an operation and maintenance manual for each type of equipment indicated in the equipment schedule section, or as specified in the specific equipment section.

B. Equipment Suppliers' standard Operation and Maintenance (O&M) Manuals shall be submitted to the Engineer no later than 15 days following approval of the shop drawings for each piece of equipment. Upon approval of the Equipment Suppliers' standard O&M Manuals and a minimum of 15 days prior to equipment startup, one electronic copy of the O&M Manual shall be submitted for use during construction. The electronic manuals shall be provided in Adobe Acrobat electronic portable document format (PDF), latest version and be viewable and searchable (where possible) on CDROM. Scanned or photocopied files/pages are not acceptable.

1.04 OPERATION AND MAINTENANCE DATA AND MANUALS

A. Operations and Maintenance Manuals and/or Standard Catalogs are to contain only that information which applies to the equipment provided. Instructions, drawings, schematics, wiring diagrams, parts lists and other materials which contain information such as optional accessories, alternate equipment arrangements, other equipment series or other equipment models which are not being provided under the contract may be included only if the Contractor neatly lined out or crosses out this information. Arrows which identify specific items of equipment or referenced items shall be made by stamp or be of drafting quality; hand-drawn arrows are not acceptable.

B. Service manuals shall contain complete and detailed operating, maintenance and repair instructions in sufficient detail to allow journeyman mechanics and Plant operators to adjust, operate, maintain and repair all components of the equipment, and to order all parts, without consultation with the manufacturer or his representative.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

3.01 PAYMENT

A. A separate fixed-price pay line item with a designated value is provided for in the Bid Form, Section 00400, Part B, for the approved O & M manuals outlined herein. This pay item is not an allowance and the Contractor must account for the designated value noted in the bid form in its total base bid price for the project and reflected as such in the schedule of value. The payment will be made as follows:

1. 50% of the pay line item will be paid in partial amounts for the submission of approved preliminary O&M Manuals as these documents are delivered for the Owner's use prior to equipment start-up and turnover of portions of the work.

2. The final 50% of the pay line item will be paid after the delivery of final O & M Manuals to the Owner prior to acceptance of the entire project for Beneficial Use.

3. Approval of O & M Manuals by the Owner is required prior to release of any payment under this pay line item.

END OF SECTION 01782

SECTION 01800

EQUIPMENT AND SYSTEM TRAINING

PART 1 GENERAL

1.01 TRAINING OF PLANT PERSONNEL

A. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

B. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

C. The training provided to the mechanical, electrical, or instrumentation maintenance personnel; the lesson plan shall be delivered one time for each specific trade material.

D. Material contained or required in the Operation and Maintenance Manuals shall be used for the development of the training program, training aids, and handouts. Promotional material will not be acceptable.

E. The following items shall be submitted for approval for each item of equipment requiring training:

1. Credentials of the equipment manufacturer representative who is to be the course instructor. This submittal shall include documentation details the instructor's general knowledge of the material he or she will teach, specific knowledge of the application of this equipment, and qualifications and history as an adult vocational instructor. Specific items are discussed below:

a. Lesson plans, to include time allotted for each entry, and lesson plans for approval 45 days prior to the proposed date for the training sessions. Include copies of all audio/visual and other training aids to be used during course of instruction and cross-reference each training aid within each subsection of the lesson plan.

b. Submit requests for scheduling training to the Engineer at least three weeks prior to the training sessions.

c. For each training class, provide instructional material for at least 10 attendees.

d. At the conclusion of training, submit 2 copies of the final lesson plan, overhead transparencies, and handouts, plus two copies of all other audio-visual aids utilized during each training course. Material shall be submitted as one final record submittal and submitted as a single transmittal for record.

2. Detailed lesson plans shall include the information outlined below:

a. Contractor's proposed lesson plans should include the elements presented in the outlines of the instruction lesson plans herein for each craft. Specific components and procedures shall be identified in the proposed lesson plans.

b. Contractor's proposed lesson plans should detail specific instruction topics. "Hands-on" demonstrations planned for the instructions shall be described in the lesson plans. Training aids to be utilized in the instruction shall be cross-referenced in the proposed lesson plans. Training strategies such as planned

blackboard work, instructor questions, and discussion points or other planned classroom or field strategies shall be detailed in the lesson plan document.

3. Handouts for training shall be attached to the lesson plans cross-referenced by section or topic in the lesson plan.

    a. The Contractor shall indicate the duration of each segment of the training lesson plans, as spelled out in the outline.

    b. The outline of the Maintenance Instruction lesson plan shall be as follows:

4. Equipment Operation: All crafts

    a. Describe equipment's operating (process) function and system theory.

    b. Describe equipment's fundamental operating principles and dynamics.

    c. Identify equipment's mechanical, electrical, and electronic components and features.

    d. Identify all support equipment associated with the operation of subject equipment.

    e. Detail the relationship of each piece of equipment or component to the subsystems, systems, and processes related to this project.

    f. Cite all hazards associated with the operation, exposure to chemicals associated with the component, or the waste stream handled by the component.

    g. Specify the appropriate and safety precautions, equipment, and procedures to eliminate, reduce, or overcome these hazards.

5. Detailed Component Description: Specific for Mechanical, Instrumentation, and Electrical/HVAC

    a. Describe PM inspection procedures required to perform an inspection of the equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).

    b. Identify and describe in detail each component function.

    c. Where applicable, group relative components into subsystems.

    d. Identify and describe in detail equipment safety features, permissive and controls interlocks.

    e. Review preventive maintenance frequency and task analysis table.

    f. Detail procedure to perform each PM activity performed weekly or less frequently.

6. Equipment Troubleshooting: Specific for Mechanical, Instrumentation, and Electrical/HVAC:

    a. Define recommended systematic troubleshooting procedures as they relate to specific craft problems.

b. Provide component specific troubleshooting checklists as they relate to specific craft problems.

7. Equipment Corrective Maintenance (CM) Specific for Mechanical, Instrumentation, and Electrical/HVAC:

   a. Describe recommended equipment preparation requirements as they relate to specific craft problems.

   b. Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.

   c. Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.

   d. Perform at least two “hands on” demonstrations of common creative maintenance repairs. Additional demonstrations may be required by the Owner.

   e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate

   f. Describe recommended procedures to check/test equipment following a corrective maintenance repair.

8. “Hands-on” instruction shall be conducted according to the following descriptions:

   a. Course instructor shall present hands-on” demonstrations of common corrective maintenance repairs for each group. The manufacturer shall provide the tools and equipment to conduct the demonstrations. Requests for supplemental assistance and facilities should be submitted with the Contractor’s proposed lesson plans. Each trainee will demonstrate skill acquisition to the satisfaction of the instructor.

   b. For those hands-on training situations where the Owner’s operations or maintenance personnel will participate in disassembly or assembly of equipment, Contractor shall be responsible for such disassembly or assembly and, on completion of all hands-on training, shall provide written certification of proper equipment operation to the Engineer. Each trainee will demonstrate skill acquisition to the satisfaction of the instructor.

   c. The second part of the training program shall be scheduled after Beneficial Use and after at least one month of operating time by plant personnel. Follow-up sessions shall consist of hands-on and classroom meetings to review previous training lessons and to answer questions from Plant personnel.

   d. Hands-on training for operations personnel will cover proper start-up, shutdown, normal and alternative operating strategies. Each trainee will demonstrate skill acquisition of the satisfaction of the instruction.

9. The Contractor shall have instructions and training sessions audio/video taped, in digital format, while they are being given to the Owner’s personnel. Audio/video taping shall be performed by a person or organization experienced in the production of tapes and shall include the entire inspection and training session (including classroom and field) and all question and answer periods. The video tape(s) or other electronic media shall become the property of the Owner.

F. The Contractor shall provide for classroom and hands-on training during regular working hours on weekdays for the plant's supervisory and operating personnel. Training shall be conducted by knowledgeable, competent personnel who are thoroughly familiar with the theory, design, operation and maintenance of the equipment. Audio quality shall not be degraded during the taping of the field sessions due to background noise, space, distance or other factors. The contractor shall provide a written release from all claims to the video taped training material produced.

G. The Plant's operating personnel shall be thoroughly trained to perform all operations covered in the instruction manuals including the assembly and disassembly of all equipment items. The Contractor shall submit for approval a detailed outline of the proposed training schedule indicating how the training will be conducted, what subjects will be covered, and estimated dates for the start and completion of each phase of training.

H. The Contractor shall bear all costs of the training program. Salaries, fringe benefits, payroll taxes, and unemployment compensation costs for plant personnel will be borne by the Authority. The cost of training shall be included in the lump sum Contract Item for Structures and Equipment Work and no separate payment will be made therefore. Training costs shall be prorated among the appropriate specifications sections in the Contractor's bid breakdown.

I. The Contractor may request to provide a DVD as a training aid to the instructor’s presentation of instruction material. DVDs must be professionally produced of good sound and video quality, contain relevant O&M information and specifically applicable to the equipment provided by this contract. The Contractor will submit the request and DVD 15 days in advance of training for Owner/Engineer review and acceptance. Submitting and acceptance of DVDs does not preclude the Contractor from conducting training as defined herein.

J. Manufacturer’s Training and summary Report, a copy of which is appended to this section will be completed by the Owner and Engineer at the completion of each vendor training session. Training sessions which receive an unsatisfactory rating by more than half the attendees shall be revised and conducted again until acceptable.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

(NOT USED)

ATTACHMENT 01800-1

MANUFACTURER'S TRAINING SUMMARY REPORT

EQUIPMENT ITEM: _____

VENDOR/MANUFACTURER:_____

DATE:_____ NAME OF REPRESENTATIVE:_____

		(Circle One)	
1.	Was representative prepared?	Acceptable	Unacceptable
2.	Was an overview description presented?	Acceptable	Unacceptable
3.	Were specific details presented for system components?	Acceptable	Unacceptable
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable
5.	Were step-by-step procedures for starting, stopping and troubleshooting presented?	Acceptable	Unacceptable
6.	Were routine and preventive maintenance items clearly identified?	Acceptable	Unacceptable
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable

10. Comments:

_____
_____
_____

11. Overall Rating: Satisfactory Unsatisfactory

Notes: Sessions judged "Unsatisfactory" by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

Engineer will attend all training sessions.

All training sessions shall be provided in standard DVD as a digital copy in DVD-ROM viewable.

END OF SECTION 01800

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 02060 - SOILS AND AGGREGATES FOR 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.

1.2 SUMMARY

A. Section Includes:

1. Soils: Soil materials and topsoil materials.
2. Aggregates: Coarse aggregate materials.

B. Related Sections:

1. Section 02300 “Earthwork.”
2. Section 02333 “Trenching and Backfilling”
3. Section 02370 “Erosion and Sedimentation Control.”
4. Section 02660 “Geotextiles for Earthwork”
5. Section 02720 “Aggregate Base Courses.”
6. Section 02920 “Turf and Grasses”
7. Section 02930 “Plants.”

1.3 ACTION SUBMITTALS

A. Section 01330 “Submittals” for requirements of submittals.

B. Samples - Soils: Submit in 5 gallon air-tight containers, 50 lbs. sample of each type of subsoil fill to testing laboratory.

C. Samples - Aggregates: Submit, in 5 gallon air-tight containers, 50 lbs. sample of each type of aggregate fill to ENGINEER at least 15 days prior to placement of backfill or fill.

D. Quality Control Testing: Submit conformance testing performed by a certified independent laboratory engaged by Contractor for all fill materials. Verify maximum density, gradation, Atterberg limits, sand equivalent, and other applicable criteria at least 72 hours prior to importing or placing any fill. Perform additional conformance testing at a minimum frequency of 1 per every 2000 cubic yards or change in material.

1.4 INFORMATIONAL SUBMITTALS

A. Materials Source: Submit name and location of imported materials suppliers.

B. Source's Certificate: Certify materials meet or exceed specified requirements.

C. Material Test Reports: For each on-site and borrow soil and aggregate material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D698.
3. Test Reports: Submit any test reports required by this Section to the Engineer.

1.5 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout the Work, unless an alternate source is approved by the Engineer.

B. Furnish each coarse and fine aggregate material from single source throughout the Work, unless an alternate source is approved by the Engineer.

C. Perform Work according to State of Virginia Highways standards.

D. Quality Control and Quality Assurance consists of laboratory conformance testing of samples supplied from each coarse source and quality control during installation.

1. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Common Fill:

1. Approved on site excavated material or imported fill material that is composed of durable soil free of debris, organic matter, or other deleterious materials.
2. Does not contain stones larger than 6 inches in largest diameter.
3. Maximum of 75 percent passing the No. 200 sieve.
4. Maximum Liquid Limit: 60 percent
5. Maximum Plasticity Index: 30 percent
6. Dry density of at least 90 pounds per cubic foot (pcf) as determined by ASTM D698.

7. Compacted to at least 92 percent of the maximum dry density as determined by ASTM D698.
8. Does not contain granite blocks, broken concrete, masonry rubble, or other similar materials and with physical properties such that it can be readily spread and compacted during filling.

B. Select Common Fill:
1. As specified above for common fill, except contains no stones larger than 2 inches in largest diameter and shall be compacted to at least 95 percent of the maximum dry density as determined by ASTM D698.

C. Structural Fill:

1. Consist of mineral soil free of organic material, loam, debris, frozen soil or other deleterious material which may be compressible, or which cannot be properly compacted,
2. Liquid Limit: between 30 and 42 percent..
3. Plasticity Index: between 10 and 20 percent.
4. Maximum Dry Density: 100 pcf minimum, as determined by ASTM D698.
5. Meets the following gradation for Sieve Size and Percent Fines by Weight:

a. 3-inch: 100.
b. No. 4: 20 to 90.
c. No. 40: 5 to 75.
d. No. 200: 0 to 40.

2.2 TOPSOIL MATERIALS

A. Topsoil (Type S3): Conforming to State of Virginia Highways standard.

2.3 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate - Crushed Stone: Natural stone; washed, free of clay, shale, organic matter; conforming to State of Virginia Highways standard.

1. Coarse Aggregate Designation: No. 57

2. Coarse Aggregate Designation: No. 21A.
   a. Percent Passing per Sieve Size:
      1) 2 inch: 100 percent
      2) 1 inch: 94 to 100 percent
      3) 3/8 inch: 63 to 72 percent
      4) No. 10: 32 to 41 percent
      5) No. 40: 14 to 24 percent
      6) No. 200: 6 to 12 percent
   b. ASTM D4791 Flat & Elongated 5:1
      1) 30% max.

2.4 SOURCE QUALITY CONTROL

A. Section 01450 “Quality Control”: Testing and inspection services. Submit test result reports to the Engineer.

B. Subsoil Material - Testing and Analysis: Perform in accordance with ASTM D698.

C. Topsoil Material - Testing and Analysis: Perform in accordance with ASTM D698.

D. Coarse Aggregate Material - Testing and Analysis: Perform according to ASTM D698.

E. When tests indicate materials do not meet specified requirements, change material and retest.

F. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different soil and aggregate materials with dividers or stockpile individually to prevent mixing. Prevent intermixing of soil types or contamination.

D. Stockpile topsoil 8 feet high maximum.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.2 STOCKPILE CLEANUP

A. Leave unused materials in neat, compact stockpile.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 02060

SECTION 02200 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 01500 "Construction Facilities and Temporary Controls"
2. Section 02370 “Erosion and Sedimentation Controls”

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than one percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed roadways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify Miss Utility for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree protection measures are in place.

D. Soil Stripping, Handling, and Hauling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 02300 "Earthwork."

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Virginia Highway Standards."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

D. Call Local Utility Line Information service not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site as indicated in drawings.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, 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. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and stockpile in areas approved by Engineer.

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, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Dispose of topsoil offsite at an approved location in a manner consistent with Virginia DEQ and Fairfax County regulations.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 02200

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 02300 - 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.

1.2 SUMMARY

A. General: Earthwork includes clearing and stripping, procurement of on-site and imported fill material, excavating, placing, and compacting fill and backfill, structural excavating and backfilling, transportation and storage of excess earthwork materials; disposal of unsuitable, waste, and surplus materials; restoration of excavation and trench surfaces; and subsidiary work necessary to complete the grading of developed areas to conform with required lines, grades, and slopes.

B. Work includes, but is not necessarily limited to; excavation for foundations, manholes, vaults, electrical manholes, conduits, cables, raceways and ducts, paving; embankments; and grading.

C. Provide services of a licensed Professional Engineer to prepare temporary excavation support system, dewatering system designs, and submittals.

D. Examine site and review available geotechnical report prior to submitting a proposal, taking into consideration project conditions that may affect the work. Owner and Design Engineer do not assume responsibility for variations of subsurface conditions at locations other than places shown and at the time investigations were made.

E. Do not initiate extra work without written notification to Owner and Engineer and receiving Owner’s written approval in response.

F. Protect existing structures and utilities that remain.

G. Related Requirements:

1. Section 02060 “Soils and Aggregates for Earthwork” for fill materials.
2. Section 02333 “Trenching and Backfilling” for stated work.
3. Section 02370 “Erosion and Sedimentation Controls” for temporary stated work.
4. Section 02660 “Geotextiles for Earthwork” for geotextile materials.
5. Section 02200 "Site Clearing" for site preparation work, including stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
6. Section 02720 “Aggregate Base Courses” for aggregates beneath paving systems.
7. Section 02740 “Asphalt Paving” for flexible paving system.
8. Section 02750 “Concrete Paving” for rigid paving systems..

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. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

C. Coverage: Pass of compaction equipment over the complete surface area of exposed lift or subgrade to receive compaction.

D. 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 Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Additional Excavation: Excavation as directed by Engineer to correct Contractor's work not in compliance with Contract Documents, which will be performed without additional compensation.
3. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
4. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be provided without additional compensation.

E. Finished Grade: Required final grade elevation indicated on Drawings. Spot elevations take precedent over proposed contours.

F. In-the-Dry: An excavation subgrade where groundwater level: has been lowered to at least 2 feet below lowest level of excavation; is stable with no ponded water, mud, or muck; is able to support construction equipment without rutting or disturbance; and is suitable for placement and compaction of fill material, pipe, or concrete foundations.

G. Objectionable Material: Includes topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over 6 inches in maximum dimension.

H. Optimum Moisture Content: Moisture content (percent by dry weight) corresponding to maximum dry density of the same material as determined by ASTM Test Method D698.

I. Overexcavation: Removal of unsuitable soil or objectionable material at or below the normal grade of excavation or subgrade as indicated on Drawings.

J. Percent Compaction: Required in-place dry density of the material, expressed as a percentage of the maximum dry density of the same material, as determined in the laboratory by ASTM Test Method D698.

K. Structures: Buildings, wet wells, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, manholes and vaults, or other man-made stationary features constructed above or below the ground surface.

L. Subgrade: Required surface of subsoil, borrow fill, or compacted fill that is immediately beneath site improvements, especially dimensioned fill, paving, or other surfacing material.

M. Unsuitable Soil: Includes existing fill materials, organic soils, weak native soils, or clays with a plasticity index of greater than 30, and any materials that cannot be properly placed and compacted as specified.

N. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

O. Zone of Influence: A line extending at least 2 feet beyond foundation or pipeline edge, then outward and downward at a slope of 1 horizontal to 1 vertical. Do no excavation below foundation of existing structures or pipeline.

P. Professional Engineer: Registered Professional Engineer meeting project qualifications and who is hired by Contractor.

Q. The Engineer: The Engineer or designated representative hired by Owner.

1. Approval given by The Engineer shall not relieve Contractor of its responsibilities for performing the work in accordance with Contract Document requirements.

1.4 ACTION SUBMITTALS

A. Samples: Submit a representative sample weighing approximately 50 pounds of each fill material, filter sand, and crushed stone contained in sealed 5-gallon containers, at least 30 calendar days prior to date of anticipated use of each material.

B. Submit laboratory test results for fill materials that include maximum density, gradation, Atterberg limits, sand equivalent, and other applicable criteria, at least 72 hours prior to importing or placing fill.

C. Prepare excavation support system designs by a licensed Professional Engineer, registered in State in which the work is located and having a minimum of 5 years of professional experience in design and construction of excavation support systems.

1. Submit an original and three copies of licensed Professional Engineer's certification, stating excavation support systems designs have been prepared by Professional Engineer who is responsible for their execution.

1.5 INFORMATIONAL SUBMITTALS

A. Construction and Operations Plan: Submit proposed methods of construction, including earthwork operations, excavation limits, slopes, fill material moisture conditioning and handling, compaction equipment, excavation support systems designs, backfilling and filling and compaction, and material sources.

1. Include additional submittal requirements related to schedule, work sequence, and on-site and off-site storage when necessary based on project conditions.

B. Submit copies of field daily reports by soil technician at the end of each workday that earthwork and grading operations occur.

C. Upon completion of earthwork and grading operations, submit an as-graded map showing density test numbers and locations, a table of density test results and depths, and a certification of compliance by geotechnical engineer in charge.

D. Qualification Data: For qualified testing agency to conduct geotechnical observation, testing and documentation. include qualifications of firm, resumes of soil technicians assigned to the project, and licensed geotechnical engineer in charge.

1. Firm Qualifications: Meet ASTM D3740.
2. Soil Technicians: Have minimum three years demonstrated experience in earthwork and grading operations and satisfy certification requirements of agency having local jurisdiction.

a. The Engineer reserves right to request substitution of soil technicians assigned to field work. Do not substitute assigned soil technicians without prior approval of The Engineer.

E. Pre-excavation 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.

1.6 QUALITY ASSURANCE

A. Excavation, trenching, sheeting, bracing, and similar work shall comply with requirements of OSHA excavation safety standards, 29 CFR Part 1926 Subpart Pand State and local authorities having jurisdiction. Where conflict between OSHA, State and local regulations exists, apply most stringent requirements.

B. At least four (4) working days prior to starting any excavation, notify the appropriate regional notification center for underground utilities and underground utility owners who are not members of notification center. To obtain area specific information for project site, refer to https://call811.com/ .

C. Quality Control Testing for Off-site Borrow Materials:

1. Chemical testing will not be required where site characterization of off-site borrow sources indicates that soils are acceptable for use. If site characterization data or materials are suspected of being contaminated, perform chemical testing as directed by The Engineer with no additional compensation.
2. Chemical Test Data: Test each material source requiring testing by a person experienced in sample collection who is a registered Professional Engineer or geologist or certified groundwater or environmental professional registered in the Commonwealth of Virginia. Submit samples of each proposed material to a chemical analytical laboratory, certified by the governing agency, for following analyses:

a. Volatile Organic Compounds: EPA 8240 plus Hazardous Substance List (HSL) Parameters.
b. Acid and Base Neutral Extractable Organic Compounds: EPA 8270.
c. Pesticides and PCBs: EPA 8080.
d. Total Petroleum Hydrocarbons: Infrared Method, EPA 9071/418.1.
e. Thirteen Priority Pollutant Metals: EPA 7000 Series.
f. Total Cyanide: EPA 9012.

3. Obtain and test off-site borrow samples in accordance with criteria established by The Engineer. Submit results for review and approval prior to use on site.

1.7 FIELD CONDITIONS

A. Be responsible for construction layout and reference staking necessary for proper control and satisfactory completion of structures, cutting, filling, grading, drainage, fencing, embankment improvements, curbing, and other appurtenances.

B. Perform construction layout and staking by a Professional Surveyor or Professional Engineer registered in State of Virginia where project occurs, experienced and skilled in construction layout and staking requirements.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earthwork operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

D. Utility Locator Service: Notify https://call811.com/ for area where Project is located before beginning earthwork operations.

E. Do not commence earthwork operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 02200 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Fill materials designated for use in this Section are specified in Section 02060 “Soils and Aggregates for Earthwork.”

B. On-Site Fill Material: Earth and rock material obtained at project site during excavation, following clearing and stripping, from which any Unsuitable Soil or Objectionable Material has been removed.

C. General: Provide imported fill materials when sufficient satisfactory soil materials are not available from excavations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, fencing, landscaping, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1. If necessary, remove and restore or replace curbing, driveway aprons, and fencing after performing backfilling work.
2. Replace existing facilities damaged by construction with new material fully equal to existing without additional compensation.

B. Prior to and During Earthwork Operations:
1. Protect and maintain erosion and sedimentation controls; coordinate with Section 02370 “Erosion and Sedimentation Controls.”

C. Clearing and Stripping. Initially clear and strip ground surfaces beneath planned structures and in areas requiring excavation or filling of organic material and debris. Do not use those materials as On-Site Fill Material; remove from the site and properly disposed.

1. Stripping Depth Variance: From about 6 inches to 8 inches.

D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

E. Saw cut existing pavement with a saw, wheel, or pneumatic chisel along straight lines before excavating.

3.2 EXCAVATION

A. Include material of every description and of whatever substance encountered as an unclassified excavation.

B. General: Excavate on-site soils using standard earthmoving equipment. Excavation in dense soil or rock may require special equipment. Do not plough, scrape, or dig earth with machinery so near to finished subgrade to result in excavation of or disturbance of below grade material.

C. Make excavations to grades indicated on Drawings and in widths sufficient for laying of pipe, construction of the structure, installing bracing, excavation supports, dewatering and drainage facilities, and working clearances.

D. Perform excavation in-the-dry and accomplished by methods which preserve the natural undisturbed condition of subgrade soils.

E. Moisture Sensitive Soils: Use a smooth-edge bucket to excavate last one foot of depth when excavation is to end in such soils.

F. If excavation bottom is removed below the limits shown on Drawings, specified, or directed by The Engineer, refill with structural fill or other material satisfactory to The Engineer without additional compensation.

G. When excavation has reached prescribed depths, notify The Engineer who will observe the conditions. If materials and conditions are not satisfactory, The Engineer will issue instructions for corrective procedures. The Engineer will be the sole judge as to whether the work has been accomplished satisfactorily.

H. Subgrade soils that have become soft, loose, quick, or otherwise unsatisfactory due to inadequate excavation, dewatering, or other construction methods in the opinion of The Engineer, remove existing soil and replaced with structural fill as acceptable to The Engineer at Contractor's expense.

I. Exposed subgrades: Conduct proof-rolling in presence of The Engineer. The Engineer will waive this requirement, if in its opinion the subgrade will be rendered unsuitable by such proof-rolling. In confined areas proof-roll with hand operated vibratory equipment that is approved by The Engineer.

J. Perform over-excavation beneath shallow foundations to remove the upper 30 inches of native soil or at The Engineer’s request to remove unsuitable soil, objectionable material, or other materials as determined by The Engineer and to such depth and width as directed. Replace with suitable material as directed by The Engineer.

1. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

K. Perform excavation for pipelines beneath structures and excavation for footings with excavating equipment operating from the subgrade for the structure, while in-the-dry and in a manner preserving the undisturbed state of subgrade soils.

L. When excavations have reached the required subgrade, including any allowances for working mats or base materials and prior to their placement, notify soils testing laboratory to verify suitability of existing subgrade soils for anticipated foundation and structural loadings.

1. If existing subgrade soils are determined to be unsuitable, follow direction provided by The Engineer regarding removal and replacement with suitable materials.
2. Notify Engineer if the revised work scope would modify Contractor's cost and thereby entitle a change to the Contract Sum. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

M. Replace over-excavation beyond the limits and depths required by Contract Documents using structural fill or other material satisfactory to The Engineer without additional compensation.

3.3 SUBGRADE PREPARATION

A. Notify Engineer when excavations have reached required subgrade.

B. Maintain excavated subgrade in-the-dry condition.

C. Prior to fill placement, remove objectionable material which includes, but not be limited to, pavement, topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over 6 inches in maximum dimension.

D. For subgrades consisting of granular soils, proof roll the final subgrade using at least four coverages of a vibrator plate compactor.

E. Remove and replace soft subgrades or unusable material with structural fill or other material satisfactory to The Engineer.

F. During wet or freezing weather, or in areas where exposed subgrade consists of moisture-sensitive soils, take measures to protect foundation excavations once they have been approved by The Engineer. Protective measures include, but are not limited to, placing insulation blankets, placing a layer of fill, pea gravel, crushed rock, or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tent.

1. If additional over-excavation is required due to the subgrade not being protected against wet or freezing weather, perform additional work without additional compensation.

G. Notify Engineer to observe conditions following subgrade preparation and prior to fill placement. If existing subgrade soils are determined to be unsuitable, follow direction provided by The Engineer regarding removal and replacement with suitable materials.

1. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

3.4 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Protect from precipitation.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.5 FILL PLACEMENT AND COMPACTION PROCEDURES

A. Fill and Backfill: Place materials in lifts to suit specified compaction requirements to required lines and grades, making allowances for settlement and placement of cover materials, such as topsoil or sod. Correct soft spots or uncompacted areas.

B. Do not place or compact fill and backfill when materials are too wet to properly compact.

1. In-place Soil Moisture Content: Maximum of three percentage points above optimum moisture content of soil, as determined by laboratory test of moisture-density relation appropriate to specified level of compaction.

C. Structural Fill and Embankment Fill: Construct to required lines and grades, making allowances for settlement and placement of cover materials, such as topsoil and sod. Correct soft spots or uncompacted areas.

D. Fill material shall be free of snow, ice, frost, and frozen earth. Do not place fill materials on frozen surfaces or surfaces covered by snow, ice, or frost.

E. Do not allow fill lifts to contain stones with a dimension larger than 2/3 the specified loose measure lift thickness.

F. Perform compaction in open areas using compaction equipment by any of the following methods:

1. Fully loaded ten-wheel trucks or front-end loaders.
2. Tractor dozers weighing minimum of 30,000 pounds.
3. Heavy vibratory rollers.

G. Confined Compaction: Perform compaction in confined areas, including areas within a 45-degree angle extending upward and outward from the base of a wall, and in areas where the use of large equipment is impractical, using hand-operated vibratory equipment or mechanical tampers.

1. Do not exceed lift thickness of 6 inches or ½ the specified lift thickness (whichever is less), measured before compaction, when using hand operated equipment.

H. Moisture condition on-site fill material prior to placement, unless Contractor demonstrates to The Engineer in-place moisture conditioning methods can achieve the required moisture content.

I. Conduct compaction of each specified lift of fill materials by a minimum of four complete coverages with acceptable compaction equipment to a specified density as a percentage of maximum dry density as determined by ASTM D1557, unless otherwise specified.

J. Use a minimum of 24 inches of structural fill and 6 inches of crushed stone beneath foundations or slabs on grade, except sidewalks. Place and compact structural fill in even lifts having a maximum thickness of 8 inches, measured before compaction.

K. Use select fill and backfill material placed within 10 feet of all structures. Uniformly place and compact select fill around the structure in even lifts having a maximum thickness of 8 inches, measured before compaction.

L. Use common fill in areas beyond those designated for structural fill or select fill, unless shown or otherwise specified. Place in even lifts having a maximum thickness of 12 inches (300 mm), measured before compaction.

3.6 COMPACTION REQUIREMENTS

A. Perform in-place testing of compacted fill lifts to measure in-place density and water content according to ASTM D6938.

B. Beneath Foundations and Slabs-on-Grade, except concrete paving: Remove upper 30 inches of existing subgrade and compact top 12 inches (300 mm) of existing subgrade and each layer of fill, if applicable to:
   1. Structural Fill:
      a. Maximum Dry Density: Minimum of 98 percent for ASTM D698.
      b. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 2 percent.
      c. Confined Areas: Lift thickness should be reduced to a maximum of 4 inches in confined areas accessible to only hand-guided compaction.
   2. Crushed Stone
      a. Compacted to a firm, unyielding condition.

C. Confined Areas: Lift thickness should be reduced to a maximum of 4 inches in confined areas accessible to only hand-guided compaction.Area Around Structures: Within 10 feet (3 meters), compact each fill or backfill layer to:

   1. Maximum Dry Density: Minimum of 92 to 95 percent for ASTM D698.
   2. Moisture Content: At or near its optimum moisture content of minus 3 percent to plus 3percent.

D. Embankments, Lawn, or Unimproved Areas: Does not include embankments under roadways and earth dam structures. Compact each fill or backfill layer to:

   1. Maximum Dry Density: Minimum of 92 percent for ASTM D698.
   2. Moisture Content: At or near its optimum moisture content of minus 1 percent to plus 4 percent.

E. Roads, Paved Areas, and Roadway Embankments: Compact each layer of fill or backfill to:

   1. Maximum Dry Density: Minimum of 95 percent for ASTM D698.
   2. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 3 percent.

3.7 DISPOSAL OF UNSUITABLE, WASTE, AND SURPLUS EXCAVATED MATERIALS

A. Unsuitable soil, objectionable material, waste, and surplus excavated material shall be removed and disposed of off-site. Materials may be temporarily stockpiled in an area within the limits of construction that does not disrupt construction activities, create any nuisances or safety hazards, or otherwise restricts access to work site.

B. Topsoil or loam excavated under this Section may be salvaged for use as specified under Section 02060 “Soils and Aggregates for Earthwork,” as approved by The Engineer.

3.8 GRADING

A. Perform grading to lines and grades shown on Drawings. Remove objectionable materials encountered within the limits indicated and disposed of off-site. Completely and continuously drained and dewatered subgrades throughout the grading process. Install temporary drains and

drainage ditches to intercept or divert surface water that may affect the execution or condition of grading work.

B. If it is not possible at the time of grading to place material in its proper section of the Work, stockpile it in approved areas for later use. No additional compensation will be made for stockpiling or double handling of excavated materials.

C. In cut areas, remove loose or protruding rocks in slopes to line or finished grade of the slope. Uniformly dress, cut, and fill slopes to slope cross-section and alignment shown on Drawings, unless otherwise directed by The Engineer.

3.9 RIPRAP AND SLOPE STABILIZATION

A. Prior to installation of riprap, install erosion control blankets on slopes in accordance with manufacturer's instructions.

1. Properly prepare area to be covered before the blanket is applied.
2. When the blanket is unrolled, place netting on top with fibers in contact with the soil over the entire area.
3. Butt blankets snugly at ends and sides, placing blankets a minimum of three rows, each four-foot wide, for a total width of 12 feet (3 meters).
4. Staple blankets together in accordance with manufacturer's instructions.
5. Secure blankets by driving staple vertically into the ground, spaced approximately 6 feet (1.5 meters) apart, on each side and one row in the center, alternately spaced between each side.
6. Do not overlap adjoining blankets. Utilize a common row of staples to attach to ground.

B. Place riprap in conjunction with embankment construction with only sufficient lag in construction of riprap protection necessary to allow for proper construction of the portion of embankment protected and to prevent mixture of embankment and riprap material.

1. Place and grade bank run gravel to a depth of 6 inches (150 mm) to obtain a continuous uninterrupted bed of required thickness within the required limits.
2. Compact by a minimum one coverage by a crawler-type tractor with a total weight, including blade and equipment, of not less than 30,000 pounds (13,600 Kg).

C. Hand-place riprap on compacted gravel bed; do not dump materials. Lay stones so maximum dimension is perpendicular to the bed. Place stones so weight of each stone is carried by underlying material and not by adjacent stones. Place large stones at the bottom of slope. Fill spaces between stones with spalls of suitable size to construct a solid, stable slope, free from large voids and defects, and to protect embankments against erosion.

3.10 FIELD QUALITY CONTROL

A. Test and observe materials as described in this Article. Cooperate by allowing free access to work for selection of test materials and observations.

B. General Testing Requirements:

1. At Structures: Prior to placement of bedding material, concrete work mats, structural fill or structural concrete, coordinate with CDM Smith's Geotechnical Services Division, Project Geotechnical Engineer or Soils Testing Laboratory to verify suitability of existing subgrade soil.

2. Backfill and Fill: Prior to and during the placement of backfill and fill coordinate with CDM Smith's Geotechnical Services Division, Project Geotechnical Engineer or Soils Testing Laboratory to perform in-place soil density tests to verify that backfill and fill material has been placed and compacted in accordance with specified compaction requirements.

    a. Provide minimum 48 hours' notice prior to placement of backfill and fill.

3. Subgrade: Do not cover with fill without observation, testing, and approval by CDM Smith's Geotechnical Services Division, Project Geotechnical Engineer or Soils Testing Laboratory.

    a. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by The Engineer without additional compensation.

C. Test materials by a certified independent laboratory, engaged by Contractor and acceptable to The Engineer, demonstrating conformance with project requirements. Deliver test reports and material certifications to The Engineer before using any material in the work.

    1. Owner will make payment for laboratory and in place density testing.

D. If field test results are not in conformance with project requirements, costs involved in correcting deficiencies in compacted materials to satisfaction of The Engineer without additional compensation.

E. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by The Engineer without additional compensation.

F. Testing methods shall comply with latest ASTM or equivalent AASHTO Standards applicable during bidding.

G. During placement of bedding, backfill, and fill, perform in-place soil density testing to confirm that fill material has been compacted in accordance with project requirements. The Engineer may designate areas to be tested. Notify Engineer at least 72 hours in advance of scheduled compaction testing. In place soil density tests on backfill and fill material shall be as required by authorities having jurisdiction, project geotechnical report, but in no instance, shall less than those listed:

    1. Structures and Embankments: At least one density and moisture content test for each 2,500 square feet of surface area for each lift of fill at embankment, structure, and manhole locations.
    2. The Engineer may designate supplemental areas to be tested at additional compensation.

H. Materials which have been previously tested may be subjected to further testing from time to time and may be rejected, if it is determined that results do not conform to project requirements. Immediately remove rejected materials when directed by The Engineer, notwithstanding results of previous testing.

I. The Engineer or Owner may conduct additional soil testing. Cooperate fully in allowing additional test to be made, including free access to the work.

3.11 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 The Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION 02300

THIS PAGE INTENTIONALLY LEFT BLANK.

SECTION 02333 - TRENCHING AND BACKFILLING

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 delegated design of trench excavation and support, backfilling, and compaction.

B. Related Requirements:

1. Section 02060 “Soils and Aggregates for Earthwork” for materials used as backfill and for sheeting and bracing.
2. Section 02660 “Geotextiles for Earthwork” for subsurface drainage geotextiles.
3. Section 02300 “Earthwork” for related earthwork activities.
4. Section 02370 “Erosion and Sedimentation Controls” to prevent erosion, sedimentation, and contamination of adjacent properties.
5. Section 02920 “Turf and Grasses.”

1.3 DEFINITIONS

A. Percent Compaction: Means at least the stated percentage of maximum density as determined by ASTM D698.

1.4 ACTION SUBMITTALS

A. Submit proposed method of backfilling and compaction prior to start of Work.

1.5 DELEGATED DESIGN SUBMITTALS

A. Submit method of trench excavation and support, where necessary, including design of sheeting and bracing with calculations signed and sealed by qualified professional engineer responsible for their preparation.

B. Qualifications Statement: Submit qualifications for licensed professional.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For material excavated from trench for re-use as backfill, by a qualified testing agency.

1.7 QUALITY ASSURANCE

A. Comply with following regulations:

1. Virginia 16VAC25-60-130 Construction Industry Standards.
2. Occupational Safety and Health Administration (OSHA): 29 CFR Part 1926 Subpart P.

B. Professional Engineer Qualifications: Licensed Professional Engineer experienced in design of specified Work and licensed in the jurisdiction of Project location; having a minimum of 5 years' experience in design and construction of trench excavation and support.

C. Provide excavation, trenching, related sheeting, bracing, and related materials to comply with requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P) and Virginia Construction Industry Standards16VAC25-60-130. Where conflict exists between OSHA and State regulations, more stringent requirements apply.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store excavated materials according to Section 02370 "Erosion and Sedimentation Control" to prevent erosion of soil type materials and contamination of adjacent water sources.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine that erosion and sedimentation controls are in place and comply with project requirements and authorities having jurisdiction.

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

2.2 PREPARATION

A. Where excavation activities occur across active vehicular or pedestrian circulation paths, use temporary controls specified in Division 01 to maintain circulation during operations required by this Section. Maintain temporary controls for each day circulation paths are restricted.

B. Coordinate work of this Section with materials specified in other Sections of Division 02.

C. Identify required lines, levels, contours, and datum locations.

D. Protect features to remain-in-place including benchmarks, existing structures, sidewalks, paving, curbs, etc. from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

2.3 TRENCH EXCAVATION

A. Trench excavation includes material of every description and substance encountered..

B. Cut rigid and flexible pavement with a saw, wheel, or pneumatic chisel along straight lines before excavating.

C. Strip and remove topsoil from grassed areas crossed by trenches.

1. Topsoil shall be removed offsite and replaced with approved topsoil of equal quality.

D. While excavating and backfilling is in progress, maintain traffic and protect utilities and other property.

E. Excavate trenches to indicated depths and in widths sufficient and of practical minimum for pipe laying, bracing, and pumping and drainage facilities.

F. Accomplish excavation and dewatering by methods preserving undisturbed state of subgrade soils. Excavate trench by machinery to or just below designated subgrade, if material remaining in trench bottom is no more than slightly disturbed.

1. Remove subgrade soils that become soft, loose, quick, or otherwise unsatisfactory due to inadequate excavation, dewatering, or other construction methods and replace with screened gravel fill acceptable to the Engineer at Contractor's expense.

G. Use care when working in clay and organic silt soils, which are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, manually excavate the last 12 inches of depth.

H. Where pipe is to be laid in screened gravel bedding, manually excavate trench to normal depth of pipe, provided material remaining in trench bottom is no more than slightly disturbed.

I. Where pipe is to be laid directly on trench bottom, manually perform final excavation, providing a flat-bottom, true to grade upon undisturbed material. Make bell holes required by project conditions.

2.4 DISPOSAL OF MATERIALS

A. Do not stockpile or stack excavated material. Remove excavated material from work site and dispose of material at approved designated areas in a manner consistent with Virginia DEQ and Fairfax County Regulations.

2.5 SHEETING AND BRACING

A. Provide and maintain sheeting and bracing required by Federal, State, or local safety requirements to support sides of excavation and prevent loss of ground which could endanger personnel, damage, adjacent structures, or delay the work.

1. Engineer may order additional supports placed at Contractor's expense if it is determined that at any point sufficient or proper supports have not been provided. Compliance with such order shall not relieve Contractor from their responsibility for sufficiency of such supports. Take care to prevent voids outside of sheeting; if voids are formed, immediately fill and ram them.

B. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support trench sides, take care in placing and moving the boxes or supporting bracing to prevent pipe movement, disturbance of pipe bedding, or screened gravel backfill.

1. Rigid Pipe Installation (such as R.C., V.C., A.C.): Raise that portion of box extending below mid-diameter above this point prior to moving box ahead to install next pipe. Perform to prevent separation of installed pipe joints due to box movement.
2. Flexible Pipe Installation (such as PVC): Do not allow trench boxes, moveable sheeting, shoring, or plates to extend below mid-diameter of pipe. As trench boxes, moveable sheeting, shoring, or plates are moved, place screened gravel to fill voids created. Re-compact screened gravel and backfill to provide uniform side support for pipe.

C. Engineer may give permission to use steel sheeting in lieu of wood sheeting for entire job wherever sheeting use is necessary. Include cost for use of sheeting in bid items for pipe, including full compensation for driving, bracing, and later removal of sheeting.

D. Carefully remove sheeting and bracing in manner to not endanger construction of other structures, utilities, or property, whether public or private. Immediately refill voids left after withdrawal of sheeting using sand by ramming with tools especially adapted to that purpose and watering or otherwise directed by the Engineer.

E. No payment will be given for sheeting, bracing, or other support during progress of the work. No payment will be given for sheeting left in trench for Contractor's convenience.

F. Leave sheeting driven below mid-diameter of pipe in place from driven elevation to at least 12 inches above top of pipe.

2.6 TEST PITS

A. Excavation of test pits may be required for purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

B. Backfill test pits as soon as desired information has been obtained. Maintain backfilled surface appropriate for travel until resurfaced.

2.7 EXCAVATION BELOW GRADE AND REFILL

A. Drain trench completely and effectively be in-the-dry, whatever the nature of unstable material encountered or groundwater conditions.

B. If Contractor excavates below grade through error or for their own convenience, through failure to properly dewater the trench, or disturbs subgrade before dewatering is sufficiently complete, the Engineer may direct Contractor to excavate below grade as set forth in following Paragraph, where work shall be performed at its own expense.

C. If material at trench bottom consists of fine sand, sand and silt or soft earth which may work into the screened gravel, even with effective drainage, remove subgrade material to extent directed. Refill excavation with a 6 inch layer of coarse sand or a mixture graded from coarse sand to fine pea stone to form a filter layer preserving voids in pipe gravel bed. Composition and gradation of gravel shall be approved by the Engineer prior to placement. Place screened gravel in 6 inch layers thoroughly compacted up to normal grade of pipe. If directed by the Engineer, use bank-run gravel for refill of excavation below grade.

D. Subsurface Drainage Geotextile: Non-woven filter fabric as specified in Section 02660 “Geotextiles for Earthwork” may be substituted for filter layer, if approved by the Engineer.

2.8 BACKFILLING

A. Begin backfilling as soon as practicable after laying and jointing pipe and continue expeditiously. Place bedding gravel of specified type for pipe installed up to 12 inches over the pipe.

B. Construct an impervious dam or bulkhead cutoff of clay or other impervious material in the trench, as directed by the Engineer, to interrupt unnatural flow of groundwater after construction is completed. Key dam into trench bottom and sidewalls. Provide at least one clay or other impervious material dam in pipe bedding between each manhole where directed or every 300 feet, whichever is less.

C. Where pipes are laid cross-country, fill remainder of trench with common fill material in layers not to exceed 12 inches and mounded 6 inches above existing grade or as directed by the Engineer. Where a loam or gravel surface exists prior to cross-country excavations, remove, conserve and replace it to full original depth as part of the work under pipe items. Where necessary, remove excess material during clean-up process, so that ground may be restored to its original level and condition.

D. Where pipes are laid in streets, backfill remainder of trench up to a depth of 12 inches below bottom of specified permanent paving with select common fill material in layers not to exceed 12 inches and thoroughly compacted. Use bank-run gravel for subbase layer of paving and compact in 6 inches layers.

E. To prevent longitudinal pipe movement, do not dump backfill material into trench and then spread, until selected material or screened gravel has been placed and compacted to a level at least 12 inches over the pipe.

F. Bring backfill up evenly on all sides. Thoroughly compact each layer of backfill material by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping to at least 95 percent according to ASTM D698 beneath paved areas and to at least 92 percent compaction according to ASTM D698 beneath unpaved areas.. If rolling, use a suitable roller or tractor being careful to compact fill throughout full width of trench.

G. Do not compact by puddling or water jetting.

H. Use hand or pneumatic ramming with tools weighing at least 20 pounds for compacting in confined areas. Spread and compact material in layers not exceeding 6 inches thick, an uncompacted loose measurement.

I. Use granular fill material as backfill around structures. Spread and compact specified backfill under and over pipes connected to structures.

J. Do not place bituminous paving in backfill. Do not use frozen material under any circumstances.

K. Broom and hose-clean road surfaces immediately after backfilling. Employ dust control measures throughout construction period.

2.9 RESTORING TRENCH SURFACE

A. Where trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate backfill and maintain surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore ground level.

B. In and adjacent to streets, 12 inches for State Highways of trench backfill below specified initial pavement shall consist of compacted bank-run gravel. If Contractor wants to use material excavated from trench as gravel subbase for pavement replacement, take samples at intervals not to exceed 500 feet of material and test by an independent testing laboratory at Contractor’s expense. Use only materials approved by the Engineer.

C. Restore surface of driveways or other areas which are disturbed by trench excavation to a condition at least equal to that existing before work began.

D. In areas where pipeline passes through grassed areas, remove and replace sod or loam and seed surface at Contractor's own expense.

END OF SECTION 02333

SECTION 02370 - EROSION AND SEDIMENTATION 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. Section Includes:

1. Diversion Channels.
2. Rock Filter
3. Sediment Fences.
4. Filter Bags.

B. Related Sections:

1. Section 02060 “Soils and Aggregates for Earthwork.”
2. Section 02200 “Site Clearing.”
3. Section 02300 “Earthwork”
4. Section 02333 “Trenching and Backfilling”
5. Section 02660 “Geotextiles for Earthwork”
6. Section 02740 “Asphalt Paving”
7. Section 02750 “Concrete Paving.”
8. Section 02920 “Turf and Grasses”

PART 2 - PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS

A. Furnish materials according to State **of** Virginia Highways standards.

B. Geotextile Fabric: Furnish according to State of Virginia Highways standards.

2.2 SILT FENCE

A.

A. Sediment fence shall be a prefabricated commercial product made of a woven, polypropylene, ultraviolet resistant material such as “Envirofence” by Mirafi Inc., Charlotte, NC or equal.

2.3 PLANTING MATERIALS

A. Seeding and Soil Supplements: as specified in Section 02920 “Turfs and Grasses”. Furnish according to State of Virginia Highways Standards.

B. Mulch: as specified in Section 02920 “Turfs and Grasses”. Furnish according to State of Virginia Highways Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support devices and imposed loads.

B. Verify gradients and elevations of base or foundation for other work are correct.

3.2 DIVERSION CHANNELS

A. Install Work according to the State of Virginia Highways Standards.

3.3 ROCK BARRIER

A. Install Work according to the State of Virginia Highways Standards.

3.4 SILT FENCE

A. Position sediment fences as indicated on the Drawings and to prevent off site movement of sediment produced by construction activities as directed by the Engineer. Areas beyond limits of silt fence shall be undisturbed or stabilized.

B. Dig trench approximately 6 inch wide and 6 inch deep along proposed fence lines.

C. Drive stakes, 10 feet on center (maximum) at back edge of trenches. Drive stakes 2 feet (minimum) into ground.

D. Hang filter fabric on posts carrying to bottom of trench with about 4 inches of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and maintain secure both ways.

E. Backfill trench with excavated material and tamp.

3.5 Install pre-fabricated silt fence according to manufacturer's instructions. SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. No stockpiling of material on-site.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 7 days.

1. During non-germinating periods, apply mulch at recommended rates.
2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 02920 “Turfs and Grasses”.
3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 02920 “Turfs and Grasses” permanent seeding specifications.

3.6 FIELD QUALITY CONTROL

A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

B. Compaction Testing: In accordance with ASTM D698.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Compaction Testing: One for each lift.

3.7 CLEANING

A. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

B. Do not damage structure or device during cleaning operations.

C. Do not permit sediment to erode into construction or site areas or natural waterways.

D. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.8 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit construction traffic over paving for 7 days minimum after finishing.

C. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION 02370

SECTION 02660 - GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

A. Section Includes:

1. Nonwoven geotextile material.

B. Related Requirements:

1. Section 02060 “Soils and Aggregates for Earthwork” for fill and grading materials.
2. Section 02300 “Earthwork” for excavation and backfilling procedures.
3. Section 02333 “Trenching and Backfilling” for trenching and backfilling procedures.
4. Section 02370 “Erosion and Sedimentation Controls” for erosion and sedimentation control devices.
5. Section 02720 “Aggregate Base Courses” for subbase and base course for placement under paving.

1.3 ACTION SUBMITTALS

A. Submit items in this Article at least 30 days prior to installation.

B. Product Data: Submit certified test results from the manufacturer including tensile strength, elongation, thickness, UV resistance, and other material properties.

C. Shop Drawings: Indicate fabric layout, seam locations, and overlap details in installation drawings. Provide installation schedule.

D. Samples for Verification:

1. Submit samples, full width by 12 inches long, for each type and weight of geotextile used on Project, illustrating thickness, color, and texture.
2. Submit samples, 12 inches by 24 inches long, for each type and weight of geotextile used on Project, illustrating each field seaming method.
3. Submit samples of securing pin and washer.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures and quality control and quality assurance.

C. Manufacturer’s quality control program and manual, including a description of laboratory facilities.

D. Source Quality-Control Submittals: Provide results of factory tests and inspections, including test results that indicate materials meet the requirements of PART 2.

E. Field Quality-Control Submittals: Provide results of Contractor-furnished tests and inspections.

F. Qualifications Statements:

1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of geotextile material, including placement depth.

1.6 QUALITY ASSURANCE

A. Perform Work according to Virginia Department of Transportation standards and the recommendations of the Manufacturer.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging that identifies the manufacturer/supplier’s name, style, and roll number. Inspect for damage.

B. Comply with ASTM D4873.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture, dust, chemicals, UV radiation or other environmental conditions that might damage the geotextile by storing at least 3 inchesoff the ground in a clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace geotextile related products that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1

2.1 MATERIALS - NONWOVEN GEOTEXTILES

A. Manufacturers:

1. Mirafi 160N.
2. Or approved equal.
3. Furnish materials according to Virginia Department of Transportation standards.

B. Description:

1. Non-biodegradable, non-reactive (for pH of three to eleven), UV-resistant, insect/rodent-resistant nonwoven needle punched material consisting of filaments formed into a stable network.
2. Edges: finished to prevent separation of outer material.

C. Performance and Design Criteria:

1. When tested in accordance with ASTM D4759, test results from any sampled roll in the lot shall meet or exceed the values listed in Table 1. Strength values are in the weaker principal direction.

TABLE 1: NONWOVEN GEOTEXTILE MINIMUM AVERAGE ROLL VALUES

PROPERTIES	TEST METHOD	UNIT	6 oz	8 oz	10 oz
Mass per Unit Area	ASTM D5261	oz/yd2	6	8	10
Thickness	ASTM D5199	mils	75	90	108
Grab Strength	ASTM D4632	lbs	160	220	260
Grab Elongation	ASTM D4632	percent	50	50	50
Trapezoid Tear Strength	ASTM D4533	lbs	60	80	100
Puncture Strength	ASTM D4833/ D6241	lbs	90	120	165
Water Flow Rate	ASTM D4491	gpm/ft2	110	95	75
Permittivity	ASTM D4491	sec-1	1.5	1.2	1.0
Apparent Opening Size (Max)	ASTM D4751	inch US Std. Sieve	0.008 70	0.007 80	0.006 100
UV Resistance	ASTM D4355	percent strength retained	70	70	70

2.2 MATERIALS - ACCESSORIES

A. Use products to secure geotextile fabrics as recommended by geotextile manufacturer.

2.3 SOURCE QUALITY CONTROL

A. If requested by the Owner, provide materials for Quality Assurance Laboratory (QAL) testing by an independent GRI accredited laboratory to confirm conformance testing results.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. The Engineer shall inspect subgrade to verify that underlying surface is smooth and free of ruts or protrusions that could damage geotextile material and that subgrade has been properly prepared.

B. Subgrade Material and Compaction Requirements: As specified in Section 02333 “Trenching and Backfilling,” Section 02333 “Earthwork,” and 02720 Aggregate Base Courses.

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

3.2 INSTALLATION

A. Comply with manufacturer's published installation instructions. Do not install damaged materials.

B. Geotextile Material:

1. Lay and maintain smooth and free of tensile stresses, folds, wrinkles, or creases.
2. Ensure that material is in direct contact with subgrade.
3. Orientate with long dimension of each sheet parallel to direction of slope and in accordance with the manufacturer’s recommendations and approved shop drawings.
4. Minimum Unseamed Joints Overlap: 18 inches.

C. Securement Pins or Staples:

1. Insert through geotextile midway between edges of overlaps and minimum 6 inches from free edges.

2. Minimum Spacing:

    a. Slopes Steeper than 3 Horizontal on 1 Vertical: 24 inches o.c.
    b. Slopes 3 Horizontal on 1 Vertical to 4 Horizontal on 1 Vertical: 3 feet o.c.
    c. Slopes Flatter than 4 Horizontal on 1 Vertical: 5 feet o.c.

3. Ensure that washer bears against geotextile.

D. Field Seams:

1. Minimum Seamed Joints Overlap: 12 inches at longitudinal and transverse joints.
2. Seams across Slope: Lap upper panel over lower panel.

E. Penetrations: As recommended by geotextile manufacturer.

F. Repairing Damaged Geotextiles:

1. Repair torn or damaged geotextile by placing patch of same type of geotextile over damaged area minimum of 12 inches beyond edge of damaged area and fasten as recommended by geotextile manufacturer.
2. Remove and replace geotextile rolls which cannot be repaired.

G. Fill and Cover:

1. Place fill to prevent tensile stress or wrinkles in geotextile.
2. Place fill from bottom of side-slopes upward.
3. Do not drop fill from height greater than 3 feet.

3.3 FIELD QUALITY CONTROL

A. Acceptance:

1. The Engineer will inspect installation and identify repairs or modifications necessary to perform as specified.
2. Make final adjustments and repairs under direction of The Engineer or manufacturer's representative.

3.4 PROTECTION

A. Ballast: Adequate to prevent uplift of material by wind.

B. UV Exposure: Do not leave material uncovered for more than 14 days after installation.

C. Do not use staples or pins to hold geotextiles in place where located adjacent to other geosynthetic layers that could be damaged.

D. Do not operate equipment directly on top of geotextile.

END OF SECTION 02660

THIS PAGE INTENTIONALLY LEFT BLANK.

SECTION 02720 - AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aggregate subbase.
2. Aggregate base course.

B. Related Sections:

1. Section 02060 “Soils and Aggregates for Earthwork”.
2. Section 02300 "Earthwork" for preparation of site for base course.
3. Section 02660 “Geotextiles for Earthwork”
4. Section 02740 "Asphalt Paving" for finish asphalt courses.
5. Section 02750 "Concrete Paving" for finish concrete surface course.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Geotextile fabric.
2. Initial aggregate test reports.

B. Samples: Submit, in air-tight containers, 10 lb sample of each type of aggregate fill to testing laboratory.

C. Materials Source: Name of aggregate materials suppliers.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work according to project’s Authorities Having Jurisdiction (AHJ) standards.

PART 2 - PRODUCTS

2.1 MATERIALS
Subbase Aggregate: select common fill

A. Base Aggregate: VDOT No. 21A

1. Percent Passing per Sieve Size:

Sieve Size		Percent Passing by Weight		
2 inches	(50 mm)	100		
1 inches	(37.5 mm)	94	to	100
3/8 inches	(9.5 mm)	63	to	72
No. 10	(2.00 mm)	32	to	41
No.40	(0.425 mm)	14	to	24
No. 200	(0.075 mm)	6	to	12

B. AGGREGATE QUALITY REQUIREMENTS

1. Aggregate for base and subbase, clean, sound, durable particles of:

   a. Crushed stone.

2. Percentage Loss of Coarse:

   a. 40 for base coarse material.
   b. 50 for subbase course material, when tested in accordance with ASTM C131/C131M.

3. Contains no more than 30 percent flat and elongated particles.
4. Contains at least 50 percent by weight of crushed pieces having two or more fractured faces as determined in accordance with ASTM D5821.

C. Fine Aggregate:

1. Screenings.
2. Angular sand.
3. Crushed recycled concrete fines.
4. Or other finely divided mineral matter.
5. Portion passing the No. 40 sieve either non-plastic or have a liquid limit less than 25 and a plasticity index less than 5.

2.2 INITIAL TESTS

A. Perform all of the following tests on the proposed material to demonstrate that it meets all specified requirements when furnished. Submit the initial test results to the Engineer for approval prior to commencement of construction.

1. Sieve Analysis.
2. Liquid limit and plasticity index.
3. Moisture-density relationship.
4. Wear Resistance to Degradation (ASTM C131/C131M).

B. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Clean the underlying course or subgrade of all foreign substances prior to constructing the subbase base course(s).

B. Do not construct base/subbase course(s) on underlying course or subgrade that is frozen.

C. Prepare the surface of the underlying course or subgrade to meet specified compaction and surface tolerances.

D. Correct ruts or soft yielding spots in the underlying courses.

E. Correct areas having inadequate compaction, and deviations of the surface from the specified requirements:

1. Loosen and remove soft or unsatisfactory material and add approved material.
2. Reshape to line and grade,
3. Recompact to specified density requirements.

F. For cohesion-less underlying courses or subgrades containing sands or gravels:

1. Stabilize the surface prior to placement of the base course(s):

a. Mix aggregate into the underlying course.
b. Compact by approved methods.
c. Do not allow traffic or other operations to disturb the finished underlying course.
d. Maintain underlying course until the base course is placed.

G. Verify that the underlying surface has been inspected, gradients and elevations are correct.

3.2 AGGREGATE PLACEMENT

A. Install geotextile fabric over subgrade according to manufacturer's instructions.

1. Lap ends and edges minimum 6 inches.
2. Anchor fabric to subgrade when required to prevent displacement until aggregate is installed.

B. Place aggregate equal thickness layers to total compacted thickness within ½ inch (13 mm) of the thickness indicated on the drawings.
1. Maximum lift Compacted Thickness: 4 inches (100 mm).

C. Level and compact the base course to within ½ inch of the thickness indicated.

D. Degree of Compaction:

1. Compact aggregate lifts to 98 percent of laboratory maximum dry density.
2. Except as noted below, degree of compaction is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557.
3. Degree of compaction for material having more than 30 percent by weight of their particles retained on the ¾ inch sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

E. Maintain optimum moisture content of material as necessary to achieve the specified degree of compaction.

3.3 FIELD QUALITY CONTROL

A. Field Density Measurements: Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167 or ASTM D6938.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

C. Frequency of Tests: One test for every 1000 square yards of each layer compacted aggregate.

END OF SECTION 02720

SECTION 02740 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.

B. Related Requirement:

1. Secction 02300 “Earthwork”
2. Section 02720 “- Aggregate Base Courses”: Compacted subbase for paving.

1.3 ACTION SUBMITTALS

A. Section 01330 “Submittals”: Requirements for submittals.

B. Product Data:

1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Certified by Virginia Department of Transportation.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with Virginia Department of Transportation Road and Bridge Standards.

1.5 AMBIENT CONDITIONS

A. Section 01500 “Construction Facilities and Temporary Controls”: Ambient conditions control facilities for product storage and installation.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

A. Performance / Design Criteria:

1. Paving: Design for parking a portable generator up to .22,000 lbs

B. Asphalt Materials:

1. Asphalt Cement : In accordance with Virginia Department of Transportation Road and Bridge Standards.
2. Primer: In accordance with Virginia Department of Transportation Road and Bridge Standards .
3. Tack Coat: In accordance with Virginia Department of Transportation Road and Bridge Standards .

C. Aggregate Materials:

1. Coarse Aggregate: ASTM D692; crushed stone, gravel, or blast furnace slag.

D. Aggregate Subbase: Specified in Section 02720 “Aggregate Base Courses”.

2.2 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: Designed in accordance with Virginia Department of Transportation Road and Bridge Standards.

1. Base Course: 4-=inch bituminous stabilized base course, type BM-25.0 A.
2. Wearing Course: 1-1/2-inch bituminous concrete surface course, type SM-9.50.

2.3 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

B. Sealant: ASTM D6690, Type I; hot applied type.

2.4 SOURCE QUALITY CONTROL

A. Section 01450 – “Quality Control”.

B. Submit proposed mix design of each class of mix for review prior to beginning of Work.

C. Test samples in accordance with AI MS-2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01450 “Quality Control”: Requirements for installation examination.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

C. Verify compacted subgrade subbase is dry and ready to support paving and imposed loads].

D. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Prepare subbase in accordance with Virginia Department of Transportation Road and Bridge Standards .

3.3 DEMOLITION

A. Saw cut and notch existing paving as indicated on Drawings.

B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 INSTALLATION

A. Subbase:

1. Prepare subbase in accordance with Virginia Department of Transportation Road and Bridge Standards .

B. Primer:

1. Apply primer in accordance with Virginia Department of Transportation Road and Bridge Standards .

C. Tack Coat:

1. Apply tack coat in accordance with Virginia Department of Transportation Road and Bridge Standards .

D. Single Course Asphalt Paving:

1. Install Work in accordance with Virginia Department of Transportation Road and Bridge Standards .
2. Place asphalt within 24 hours of applying primer or tack coat.
3. Place asphalt wearing course to thickness identified in schedule at end of section.
4. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

E. Asphalt Paving Overlay

1. Apply asphalt cement[tack coat] to existing paving surface at rate recommended by geotextile fabric manufacturer.
2. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches
3. Place wearing course to thickness indicated on Drawings.
4. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.5 FIELD QUALITY CONTROL

A. Take samples and perform tests in accordance with Virginia Department of Transportation Road and Bridge Standards Asphalt Paving Density: ASTM D1188 or ASTM D2726; test one core sample from every 1000 square yardscompacted paving.

3.6 PROTECTION

A. Immediately after placement, protect paving from mechanical injury for 2 hours or until surface temperature is less than 140 degrees F

END OF SECTION 02740

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 02750 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Aggregate base course.
2. Concrete paving: Constructing Portland cement concrete pavement, plain or reinforced in accordance with these specifications and with the lines, grades and dimensions shown on the plans. Specifically, the work includes:

    a. Designing the concrete mix.
    b. Preparation of subgrade and subbase material.
    c. Installation of steel reinforcement, dowel bars and tie bars.
    d. Furnishing, transporting, placing, consolidating, finishing and texturing of concrete.
    e. Furnishing concrete admixtures and additives.
    f. Constructing all joints and furnishing joint materials.
    g. Marking the pavement.
    h. Curing the pavement and furnishing all curing materials.

3. Quality Control of Concrete paving includes:

    a. Furnishing concrete necessary for making test beams and/or cylinders.
    b. Performing maturity testing.
    c. Coring and patching the pavement.
    d. Calibrating and checking the operation of batching equipment.
    e. Taking actions necessary to prevent or to repair cracking.
    f. Sawing and sealing joints.
    g. Verifying dowel bar alignment.
    h. Removing and replacing, or repair of defective pavement.

B. Related Requirements:

1. Section 02720 “Aggregate Base Courses”
2. Section 02760 “Concrete Paving Joint Sealants” for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 ACTION SUBMITTALS

A. Submit, in accordance with Section 01330 “Submittals”, detailed information on materials proposed and installation methods.

B. Product Data: Submit data on material and equipment to be used in concrete pavement including:

1. Sources of aggregate, manufacturer data sheets for cement and concrete admixtures used in the concrete mix design.
2. Dowels and dowel bar assemblies.
3. Reinforcement or welded wire mesh.
4. Equipment to be used for placement, consolidation finishing, texturing and curing of concrete pavement.
5. Material and equipment to be used for joint installation including joint fillers, joint sealants, and saw-cutting and joint cleaning equipment.

C. Proposed Techniques: submit proposed techniques for placement, consolidation, finishing texturing and curing of concrete, and methods of concrete joint installation.

D. Pavement jointing plan showing joint types based on the proposed methods of installation.

E. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

F. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: 10 lb Sample of each mix.

G. Concrete Mix Design Data:

1. Submit concrete mix design for each concrete strength.
2. Identify mix ingredients and proportions, including admixtures.
3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.

1.4 INFORMATIONAL SUBMITTALS

A. Source Quality Control Submittals: Indicate results of factory tests and inspections.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum [five years' documented experience .

B. Lead Foreman of the paving operations: shall have minimum five years’ experience and shall be an ACI Concrete Flatwork Technician/Finisher.

C. Curing Crews: ACI Concrete Flatwork Technician/Finisher

D. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

E. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

F. Obtain concrete mix constituents from same sources throughout the paving work

1.6 FIELD CONDITIONS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

B. Do not begin placement of concrete unless the ambient temperature is at least 35 degrees Fand rising.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Mix Design Requirements: Design concrete mix in accordance with 325.14R-17 (Guide for Design and Proportioning of Concrete Mixtures for Pavements.

B. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feetor less.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

D. Steel Reinforcement
1. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from steel wire into flat sheets.
2. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
3. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
4. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
5. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.
6. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
7. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
8. Plain-Steel Wire: ASTM A1064/A1064M,.
9. Deformed-Steel Wire: ASTM A1064/A1064M.

10. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, plain.
11. Dowel Bars: ASTM A615/A615M, Grade 60plain-steel bars, zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
12. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
13. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
14. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
15. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

2.2 CONCRETE MATERIALS

A. Cementitious Materials: Provide cementitious materials consisting of portland cement, blended, cement or only portland cement in combination with supplementary cementitious materials (SCM), that conform to appropriate specifications listed below. Use cementitious materials, of same type, brand, and source throughout Project.

1. Portland Cement: ASTM C150/C150M, portland cement Type II.
2. Blended Hydraulic Cement: Provide blended cement conforms to ASTM C595/C595M, Type IP or IS. Type IP blend shall only include ASTM C618 Class F or Class N pozzolan. Include in written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement throughout production for the project.
3. Supplementary Cementitious Materials (SCMs):

    a. Fly Ash: ASTM C618, Class F.
    b. Raw or Calcined Natural Pozzolan: ASTM C618, Class N.
    c. Slag Cement: ASTM C989/C989M, Grade 120.

B. Aggregates:

1. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source.
2. Maximum Coarse-Aggregate Size: 1 inch nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
4. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
5. Aggregate Sizes: 1/2 to 3/4 inch nominal.

C. Admixtures:

1. Air-Entraining Admixture: ASTM C260/C260M.

2. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
3. Water-Reducing Admixture: ASTM C494/C494M, Type A.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation-Construction Systems.
b. Bon Tool Co.
c. Brickform; a division of Solomon Colors.
d. ChemMasters, Inc.
e. Dayton Superior.
f. Euclid Chemical Company (The); an RPM company.
g. Kaufman Products, Inc.
h. L&M Construction Chemicals, Inc.
i. Lambert Corporation.
j. Metalcrete Industries.
k. Nox-Crete Products Group.
l. Sika Corporation.
m. SpecChem, LLC.
n. TK Products.
o. Vexcon Chemicals Inc.
p. W.R. Meadows, Inc.
q. Or equal.

E. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.4 CONCRETE MIXTURES REQUIREMENTS

A. General:

1. Prepare design mixtures, proportioned according to ACI 325.14R-17, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
2. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
3. Design the mix to achieve a 28-day compressive strength of 4500 psi.
4. Design the mix with 0.45 maximum W/C ratio at the point of placement.
5. Maximum slump at the point of placement: 4 inch.
6. Provide a concrete mix with minimum cementitious material (i.e. Portland cement + supplemental cementitious material) content meeting the requirements of Table 5.4.5.1a of ACI 325.14R-17.

B. Aggregate:

1. Provide coarse and fine aggregate for the concrete mix from sources approved by Virginia DOT.
2. Provide coarse and fine aggregate consisting of clean, hard, durable particles meeting the requirements of ASTM C33/C33M.
3. Provide coarse aggregate with 1 inch nominal maximum aggregate size.
4. Coarse and fine aggregate shall consist of particles that are generally spherical or cubical in shape.
5. Coarse aggregates shall be clean and free of deleterious material as follows:

    a. Clay lumps and friable particles (ASTM C142/C142M) < 2.0% by mass.
    b. Material finer than 0.075 mm No. 200 sieve (ASTM C117): < 1.0%.
    c. Lightweight particles (ASTM C123/C123M): < 1.0%.
    d. Total of all deleterious substances, exclusive of material finer than 0.075 mm No. 00 sieve: < 5.0%.

6. Fine aggregates shall be clean and free of deleterious material as follows:

    a. Clay lumps and friable particles (ASTM C142/C142M) < 1.0% by mass.
    b. Material finer than 0.075 mm No. 200 sieve (ASTM C117): < 3.0%.
    c. Lightweight particles ASTM C123/C123M: < 0.5%.

7. The aggregate shall be resistant to deterioration due to freeze and thaw cycles as determined by test method ASTM C666.
8. The aggregate shall not have potential for alkali-silica reactivity (ASR) with cement as determined by ASTM C1778 or AASHTO PP65.
9. Provide coarse aggregate with no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M.
10. The combined coarse and fine aggregate grading shall be optimized in accordance with the guidelines of Section 5.4.10 of ACI 325.14R-17.

C. Portland Cement:

1. Provide ASTM C150/ 150M Portland Cement Type I or II.

2. Provide Blended cements ASTM C595/595M Type IP, IL or IT.

D. Supplementary Cementitious Materials (SCMs): Supplementary Cementitious Materials used in paving concrete shall conform to the following requirements:

1. Fly Ash: Provide fly ash that conforms to ASTM C618, Class F.
2. Natural Pozzolan: natural pozzolan that is raw or calcined shall conform to ASTM C618, Class N.
3. Slag Cement: Provide slag cement (ground-granulated blast-furnace slag) that conforms to ASTM C989/C989M, Grade 100 or Grade 120.
4. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

    a. Fly Ash + Natural Pozzolan: 35 percent.
    b. Slag Cement: 50 percent.
    c. Combined Fly Ash and Slag Cement: 50 percent, with fly ash not exceeding 25 percent.
    d. Combined Pozzolan and Slag Cement: 50 percent, with Pozzolan not exceeding 25 percent.

E. Concrete Admixtures:

1. General: Concrete chemical admixtures may include water reducers, retarders, accelerators, air-entrainers. When multiple admixtures in the same mixture, incompatibility issues should be avoided by using admixtures from the same manufacturer.
2. Air Entrainment Admixture (ASTM C260): Add air-entraining admixture to result in normal-weight concrete at point of placement having an air content of 4+/-1.5%. The amount of air entrainment admixtures to be added shall be determined based on the admixture's manufacturer recommendations and trial mixes.
3. Water-Reducing Admixtures (WRAs): Use water-reducing admixture when required to increase strength and improve workability. Normal WRAs, ASTM C494/C494M Type A and water-reducing and retarding admixtures, Type D. High-range water-reducing admixtures (HRWRAs) shall be of Types F or G.
4. Retarding Admixtures: When used, retarders shall be ASTM C494/C494M Type A or Type D.

2.5 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch tickets for each batch discharged and used in the Work.

B. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

C. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

2.6 SOURCE QUALITY CONTROL

A. Provide mix design for concrete paving.

B. Submit proposed mix design to appointed firm for review prior to commencement of Work.

C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

D. Test samples according to ASTM C94/C94M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

C. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.

D. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

E. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 02300 "Earthwork."

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

G. Ensure that sufficient area is prepared and compacted beyond the edge of paving. This area will be used as a wheel track for the paver or as a foundation for the side forms.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. The grade must be kept uniformly moist immediately before concrete is placed. Verify that the base is sprinkled sufficiently ahead of the paving train to keep the material moist without ponding water.

3.3 INSTALLATION

A. Edge forms and screed:

1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

B. Steel Reinforcement

1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

C. Joints

1. Construct joints that conform to the locations and details in the plans. Joints shall be constructed perpendicular to the finished grade of the pavement. Provide joints that are straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 1/2 inch.
2. Change from the jointing pattern shown on the design drawings or the approved shop drawings is not allowed without written approval.
3. Seal joints immediately following curing of the concrete or as soon thereafter as weather conditions permit.
4. When Joints intersect each other, it should be at a right angle. Also, joints should form 90-degree angles with free pavement edges. When the alignment of a joint is less than 90 degrees with a free edge, route the last 3 feet of the joint to run perpendicular to the free edge.
5. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated on the plans. When new joints mismatch existing joints, provide steel reinforcement for the first row of panels in the new concrete pavement.
6. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
7. Provide tie bars at sides of paving strips where indicated.
8. Contraction (Control) Joints: The purpose of contraction joints is to relieve early shrinkage stress within the pavement.

a. Contraction joints must be cut as soon as the concrete has hardened enough to support the saw equipment and allow cutting without excessive chipping, spalling or tearing of the cut.
b. Require immediate correction of the operation if excessive raveling occurs during sawing.
c. If a sharp edge joint is being obtained on control cutting, it can generally be regarded that the concrete has hardened excessively, and sawing is being conducted late.

9. Verify that joints are centered over dowels.

a. Saw the joints at the required spacing consecutively in the sequence of the concrete placement.
b. Immediately after the joint is sawed, thoroughly flush the saw cut and adjacent concrete surface with water and vacuumed until all waste from sawing is removed from the joint and adjacent concrete surface.
c. Respray the surface around the joint with curing compound as soon as free water disappears.
d. Take necessary precautions to ensure that the concrete is properly protected from damage and cured at sawed joints.
e. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, or as shown on the plans. Construct contraction joints by grooving or saw-cutting as follows:

10. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4 inch radius. Repeat grooving of contraction joints after applying surface finishes.

a. Tolerance: Ensure that grooved joints are within 3 inch either way from centers of dowels.

11. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inch either way from centers of dowels.

12. Construction Joints: Set construction joints at side forms and at end terminations of paving where paving operations are stopped for more than one-half hour. Provide construction joints at a planned joint location. Install dowels in the construction joints, or thicken the edges as indicated.
13. Isolation/ Expansion Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

a. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
b. Terminate joint filler not less than 1/2 inch or more than 1 inchbelow finished surface if joint sealant is indicated.

c. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
d. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

14. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4 inch radius. Repeat tooling of edges after applying surface finishes.

D. Concrete Hauling and Placement.

1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.
5. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
6. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing is completed.
7. Deposit and spread concrete in a continuous operation inside formed area. Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material. Do not push or drag concrete into place or use vibrators to move concrete into place.
8. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Insert vibrators into the concrete to a depth that provides the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Insert hand-operated vibrators between 6 to 15 inches (150 to 400 mm) on centers. Excessive vibration is not permitted. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) requires the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.
9. Consolidate concrete along face of forms with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
10. Screed paving surface with a straightedge and strike off.
11. Initial floating stage between screeding and final float finish is included in this article rather than in "Concrete Protection and Curing" Article.
12. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.4 TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:

B. ACI 117 (ACI 117M) establishes few paving tolerances; those in subparagraphs below are based on ACI 330.1. Revise to suit Project.

C. Elevation: 3/4 inch.

D. Thickness: Plus 3/8 inch, minus 1/4 inch.

E. Surface: Gap below 10 feet long; unleveled straightedge not to exceed 1/2 inch.

F. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.

G. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm) 1 inch.

H. Vertical Alignment of Dowels: 1/4 inch.

I. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.

J. Joint Spacing: 3 inch.

K. Contraction Joint Depth: Plus 1/4 inch, no minus.

L. Joint Width: Plus 1/8 inch, no minus.

3.5 FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inchdeep with a stiff-bristled broom, perpendicular to line of traffic.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg Fand below and when it is 80 deg Fand above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
7. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Coring: provide concrete cores at least 4 inch in diameter by full depth cut from points selected in the test section by the Engineer. The cores will be evaluated for surface paste, uniformity of aggregate distribution, segregation, voids, and thickness.

G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

H. Concrete paving will be considered defective if it does not pass tests and inspections.

I. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

J. Prepare test and inspection reports.

K. Strength Test Samples:

1. Sampling Procedures: ASTM C172.
2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured.
3. Sample concrete and make one set of three cylinders for every 75 cu yds ([**57**] cu m) or less of each class of concrete placed each day and for every 5,000 sf (465 sq m) of surface area paving.
4. Make one additional cylinder during cold weather concreting, and field cure.

L. Field Testing:

1. Slump Test Method: ASTM C143/C143M.
2. Air Content Test Method: ASTM C173/C173M.
3. Temperature Test Method: ASTM C1064/C1064M.
4. Measure slump and temperature for each compressive strength concrete sample.
5. Measure air content in air entrained concrete for each compressive strength concrete sample.

M. Cylinder Compressive Strength Testing:

1. Test Method: ASTM C39/C39M.
2. Test Acceptance: Average compressive strength of three consecutive test maximum 500 psiless than specified compressive strength according to Virginia DOT Road and Bridge Standards.
3. Test one cylinder at 7 days.
4. Test two cylinders at 28 days.
5. Dispose remaining cylinders when testing is not required.

N. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.7 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Coordinate minimum requirements for concrete strength with expected traffic conditions.

C. Do not permit vehicular traffic over paving for 7 days minimum after finishing.

D. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

E. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

F. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

G. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

H. Concrete Protection

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.

I. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x hbefore and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

J. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

K. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12 inchlap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inch, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.
4. Maintain temperature of air next to concrete above 40 deg Ffor the full curing periods.

END OF SECTION 02750

SECTION 02760 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Cold-applied, fuel-resistant joint sealants.
3. Joint-sealant backer materials.
4. Primers.

B. Related Requirements:

1. Section 02750 “Concrete Paving”.

1.3 ACTION SUBMITTALS

A. Product Data: submit manufacturer certificate (data sheet) for each type of product and installation recommendations.

B. Copies of test reports.

C. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Qualification Data: For Installer

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Perform testing of materials in an approved independent laboratory and submit certified copies of test reports for approval 15 days prior to use of materials at the job site.

1.5 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When temperature within the joint wall is outside limits permitted by joint-sealant manufacturer.
2. When moisture is observed within joint.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
5. On same day as sawing occurred.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Cold-Applied Joint Sealants:

1. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D 5893M, Type NS.]
2. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D 5893M, Type SL.
3. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.
4. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
5. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

C. Cold-Applied, Fuel-Resistant Joint Sealants:

1. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
2. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

D. Joint-Sealant Backer Materials:

1. Provide backer material that is a compressible, nonshrinking, nonabsorbing material. Use backer material that is 20 to 30 percent larger in diameter than the nominal width of joint. Backer material shall be nonreactive with proposed joint sealant. Material shall have a melting point at least 5 degrees F (3 degrees C) greater than pouring temperature of sealant being used when tested in accordance with ASTM D789. Material shall also have

a water absorption of not more than 5 percent of sample weight when tested in accordance with ASTM C1016.

2. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
3. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
4. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

E. Primers:

1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

C. Inspect application equipment to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Evidences of bubbling, or improper installation will result in suspending operations until causes of deficiencies are determined and corrected.

3.2 PREPARATION

A. Removal of existing sealant: cut loose in-place sealant from both joint faces and to depth indicated on drawings, using routing equipment, concrete saw, or waterblaster. Prior to further cleaning operations, remove loose old sealant remaining in joint opening by blowing with compressed air.

B. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions. Thoroughly clean joints to remove laitance, curing compound, and protrusions of hardened concrete.

1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION

A. Seal joints immediately following final cleaning of joint walls and following placement of backup material. Open joints, that cannot be sealed under conditions specified, or when rain interrupts sealing operations shall be recleaned and allowed to dry prior to installing sealant.

B. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless installation instructions are modified by Engineer.

C. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

D. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability:

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill joint from the bottom up to ¼ inch plus or minus 1/16th inch (6 mm plus or minus 2.0 mm) below pavement surface.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
4. Remove and discard excess or spilled sealant from pavement by approved methods.
5. Install sealant in such a manner as to prevent formation of voids and entrapped air.
6. Do not permit traffic over newly sealed pavement until authorized.

F. Tooling of Non-sag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3.4 PROTECTION

A. Clean off excess joint sealant as Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from original work.

END OF SECTION 02760

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 02920 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Seeding.

B. Related Requirements:

1. Section 02060 “Soils and Aggregates for Earthwork” for topsoil requirements.

2. Section 02370 “Erosion and Sedimentation Controls” for protection from soil erosion.

3. Section 02930 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 02060 "Soils and Aggregates for Earthwork" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging:

1. Certification of each seed mixture for turfgrass, sod or plugs. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment:

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.:

1. Spring Planting: May 1st through August 15th.
2. Fall Planting: August 16th through October 1st.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with Association of Official Seed Analysts (AOSA's) "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: State-certified seed of grass species as listed below for solar exposure.
2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
3. Minimum Care Lawn

    a. 175-200 lbs Commercial or Residential: Proportioned by weight as follows:

        1) 95-100% percent Kentucky 31 or Turf-Type Tall Fescure (festuca arundinacea).
        2) 0-5% Improved Perennial Ryegrass (lolium perenne)
        3) 0-5% Kentucky Bluegrass (poa pratensis)

2.2 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 15 percent nitrogen, 30 percent phosphorous, and 15 percent potassium, by weight.

2.3 LIME

A. Description: Agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent.

B. Comply with ASTM C602.

C. Class: T.

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.

2.4 MULCHES

A. Straw or Hay Mulch: free from weeds and coarse matter. Must be anchored. Spread with mulch blower or by hand. Apply at a rate of 70-90 lbs per 1000 sq. ft.

B. Fiber Mulch: do not use as mulch for winter cover or during hot, dry periods. Apply as slurry at a rate of 35 lbs per 1000 sq. ft. When fiber mulch is the only available mulch during periods when straw should be used, apply at a minimum rate of 45 lbs per 1000 sq. ft.

C. Corn Stalks: cut or shredded in 4-6 in lengths. Air-dried. Do not use in fine turf areas. Apply with mulch blower or by hand. Apply at a rate of 185-275 lbs per 1000 sq. ft.

D. Wood chips: free of coarse matter. Air-dried. Treat with 12 lbs nitrogen per ton. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand. Apply at a rate of 185-275 lbs per 1000 sq. ft.

E. Bark chips or shredded bark: free of coarse matter. Air-dried. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand. Apply l at a rate of 1-2 cu. Yds. Per 1000 sq. ft.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work:

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations:

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LIMING AND FERTILIZING

A. Apply lime at application rate recommended by soil analysis.

B. Work lime into top 6 inches of soil.

C. Apply fertilizer at application rate recommended by soil analysis.

D. Apply fertilizer after smooth raking of topsoil and prior to installation of sod.

E. Apply fertilizer no more than 48 hours before laying sod.

F. Mix fertilizer thoroughly into upper 4 inches of topsoil.

G. Lightly water soil to aid dissipation of fertilizer.

3.4 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 02060 “Soils and Aggregates for Earthwork” and Section 02200 “Site Clearing.”

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph:

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 2 lb/1000 sq. ft..

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment:

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

E. Protect seeded areas from hot, dry weather or drying winds by applying bark chips or shredded bark within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches:

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow Kentucky 31 to a height of 1/2 inch or less.

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry:

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by the Owner:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.8 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 02920

SECTION 02930 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Trees.
2. Mulch.
3. Fertilizer.
4. Pruning.
5. Maintenance.

B. Related Sections:

1. Section 02300 “Earthwork” for excavating, filling and backfilling, compacting, and grading.
2. Section 02333 “Trenching and Backfilling” for trenching and backfilling for utilities outside of buildings, usually extending to utility service connections.
3. Section 02060 “Soils and Aggregates for Earthwork” for topsoil mixtures.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.4 SUBMITTALS

A. Section 01330 “Submittals” for requirements for submittals.

B. Product Data: Submit list of plant material sources, data for fertilizer and other accessories.

C. Submit minimum 10 oz sample of topsoil proposed. Forward sample to testing laboratory in sealed containers to prevent contamination.

1.5 CLOSEOUT SUBMITTALS

A. Section 01770 “Contract Closeout” for requirements for submittals.

B. Operation and Maintenance Data: Include pruning objectives, types, and methods.

1.6 QUALITY ASSURANCE

A. Tree Pruning: ANSI A300 Pruning Standards for Woody Plants.

B. Perform Work according to Virginia Department of Transportation Road and Bridge Standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

D. Plant material damaged as a result of delivery, storage or handling will be rejected.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.

B. Do not install plant life when wind velocity exceeds 30 mph.

1.9 COORDINATION

A. Section 01310 “Project Meetings for requirements for coordination.

PART 2 - PRODUCTS

2.1 TREES, PLANTS, AND GROUND COVER

A. Planting Stock:

1. Species: According to Standardized Plant Names, official code of American Joint Committee on Horticulture Nomenclature.
2. Identification: Label individual plants or each bundle of plants when tied in bundles.
3. Plants: No. 1 Grade conforming to "American Standard for Nursery Stock" of American Association of Nurserymen (AAN); well-branched, vigorous and balanced root and top

growth; free from disease, injurious insects, mechanical wounds, broken branches, decay and other defects.

4. Trees: Furnish with reasonably straight trunks, well balanced tops, and single leader.
5. Deciduous plants: Furnish in dormant state, except those specified as container grown.

B. Trees: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work.

2.2 SOIL MATERIALS

A. Topsoil: As specified in Section 02060 “Soils and Aggregates for Earthwork”

2.3 MULCH MATERIALS

A. Mulching: As specified in Section 02920 “Turfs and Grasses”

2.4 ACCESSORIES

A. Wrapping Materials: Burlap.

B. Stakes: Softwood lumber, pointed end.

C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.

D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01310 “Project Meetings” for verification of existing conditions before starting work.

B. Verify prepared subsoil and planters are ready to receive work.

C. Saturate soil with water to test drainage.

D. Verify required underground utilities are available, in proper location, and ready for use.

3.2 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.

C. Scarify subsoil to depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Dig pits and beds three times wider than plant root system.

3.3 PLACING TOPSOIL

A. Spread topsoil to minimum depth of 4 inches over area to be planted. Rake smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install topsoil into pits and beds intended for plant root balls, to minimum thickness of 6 inches.

3.4 FERTILIZING

A. Apply starter fertilizer.

B. Apply after initial raking of topsoil.

C. Mix thoroughly into upper 2 inches of topsoil.

D. Lightly water soil to aid dissipation of fertilizer.

3.5 PLANTING

A. Place plants for best appearance.

B. Set plants vertical.

C. Remove non-biodegradable root containers.

D. Set plants in pits or beds, partly filled with prepared plant mix, at minimum depth of 6 inchesunder each plant. Loosen burlap, ropes, and wires, from top half of root ball.

E. Place bare root plant materials so roots lie in natural position. Backfill soil mixture in 6 inchlayers. Maintain plant life in vertical position.

F. Saturate soil with water when pit or bed is half full of topsoil and again when full.

3.6 TREE PRUNING

A. When pruning trees is required, lightly prune trees according to ANSI A300 Maintenance Pruning Type: Crown Cleaning.

3.7 FIELD QUALITY CONTROL

A. Section 01450 “Quality Control” for field inspecting, testing, adjusting, and balancing.

B. Plants will be rejected when ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.8 SCHEDULE

A. Tree Schedule:

1. ID:

    a. Botanical Name: Illex x aquipernyi .
    b. Common Name: Dragon Lady Holly.
    c. Height: 5 feet minimumSpacing: 36 inches on-center
    d. Balled and burlapped.

2. IB:

    a. Botanical Name: Illex x meserveae.
    b. Common Name: Blue Stallion Holly.
    c. Height: 5 feet minimum
    d. Spacing: 36 inches on-center
    e. Balled and burlapped.

END OF SECTION 02930

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 03015 - MODIFICATIONS TO EXISTING 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 SUMMARY

A. Section includes:

1. Cutting, removing, or modifying parts of existing concrete structures or appurtenances.
2. Addressing existing steel reinforcing bars encountered.
3. Bonding new concrete or grout to existing concrete.

B. Related Requirements:

1. Section 03303 “Cast-In-Place Concrete and Reinforcing” for concrete materials, and related work.
2. Section 03600 “Grouting” for grout and related accessories.
3. Section 05051 “Post-Installed Anchors” for anchors and related accessories.
4. Section 05502“Metals Fabrications” for various metals and related fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Submit manufacturer's technical literature and installation instructions that include:

a. Current printed recommendations and product data sheets for products including performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, volatile organic compound data, and safety requirements.
b. Storage requirements including temperature, humidity, and ventilation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Documentation of the qualifications for Contractor qualifications, Manufacturer's qualifications, and Contractor's supervisor as specified in Part 1 “Quality Assurance” Article.

B. Material Certificates: For each material provided.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Have a minimum of ten years' experience within last 10 years in manufacture and use of specified products and have an ongoing program of training, certifying, and technically supporting Contractor's personnel.

B. Contractor Qualifications: Complete a program of instruction in application of approved manufacturer's material and provide certification from manufacturer attesting to their training and status as an approved applicator.

C. Contractor's Supervisor: Have attended a training program sponsored by manufacturer supplying materials approved for this project.

D. Manufacturer's Representative: A representative of product manufacturer who will visit the site for first three days of installation to give instructions to installation crew. Make periodic site visits to ensure products being installed are in accordance with published instructions.

E. Be solely responsible for workmanship and quality of modification work. Inspections by the manufacturer, the Engineer, or others do not limit Contractor's responsibility for work quality.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in original, new and unopened packages and containers clearly labeled with the following information:

1. Manufacturer's name.
2. Name or title of material, and other product identification.
3. Manufacturer's stock number and batch number.
4. Date of manufacture.
5. Instructions.
6. Expiration date.

B. Storage: Store products in accordance with manufacturers' published recommendations and the following supplementary requirements:

1. Store only approved materials on site and in locations as directed.
2. Keep area clean and accessible.
3. Comply with health and fire regulations including those of the Occupational Safety and Health Administration (OSHA).

C. Handling: Handle products carefully and in accordance with manufacturers' published recommendations and the following supplementary requirements:

1. Prevent inclusion of foreign materials.
2. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with this Section and applicable state and local regulations.

B. Epoxy Bonding Agent:

1. Product: Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C 881, Type V, Grade 2, Class C.

C. Epoxy Paste Adhesive:

1. Product: Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C 881, Type IV, Grade 3, Class C.

D. Repair Mortar (Polymer-Modified Portland Cement Mortar):

1. Horizontal Surfaces:

a. Product: Two-component polymer-modified, portland cement based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 7,000 psi at 28 days tested in accordance with ASTM C 881 or ASTM C 109.

2. Vertical and Overhead Surfaces:

a. Product: Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psi at 28 days tested in accordance with ASTM C 881 or ASTM C 109.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which modification work is to be installed, and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION - GENERAL

A. Do not shift, cut, remove, or otherwise alter existing structure or concrete until authorization is given by the Engineer.

B. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.

C. Unless otherwise permitted, shown, or specified, cut existing concrete by line drilling.

D. Construction Tolerances: Comply with requirements specified elsewhere in Division 03, except as modified herein, and elsewhere in Contract Documents.

E. Make locations and phases of the work available for access by the Engineer or other personnel designated by the Engineer. Provide ventilation and safe access to the work.

F. Cut, remove, or otherwise modify parts of existing structures or appurtenances as indicated, specified, or as necessary to complete the work. Finishes, joints, reinforcements, sealants, and similar materials are specified in their respective Sections. Install work complying with requirements of this Section and as indicated.

G. Locations, details, and limits of modifications are indicated on Drawings. Comply with requirements of this Section and as indicated on Drawings.

H. Examine areas and conditions under which modification work is to be installed, and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

I. Store, mix, apply, and cure materials in strict compliance with manufacturer's instructions.

J. Where concrete is to be modified near an expansion joint or control joint, preserve isolation between components on either side of the joint.

K. When drilling holes for dowels and bolts or when coring holes for slab or wall penetrations, stop drilling if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Relocate hole to avoid reinforcing as approved by the Engineer.

    1. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference.

L. Saw-cut edges for modification areas vertically and horizontally straight. Make intersecting cuts perpendicular to each other.

M. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Identify reinforcing locations within 1 foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.

N. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by

sandblasting, oil-free air-blasting, scarifying, or other mechanical means to sound original concrete.

O. Consolidate modification materials, completely filling portions of the area to be filled.

P. Bring finished surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture including any coatings or surface treatments that had been provided for the existing structure.

Q. Repair or replace concrete indicated or specified to be left in place that is damaged because of the work by approved means without additional compensation.

3.3 CONCRETE REMOVAL

A. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.

B. Concrete designated to be removed to specific limits indicated or directed by the Engineer, perform saw cutting 1 inch deep at limits of removal followed by line drilling and chipping, sandblasting, or oil-free airblasting, as appropriate in the areas where concrete is to be taken out. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.

1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, herein specified, or after obtaining written approval from the Engineer.

C. Where existing reinforcing is exposed due to saw cutting or line drilling and no new material is to be placed on cut surface, apply a 1/4 inch thick surface treatment of epoxy paste to entire cut surface.

D. Where joint between new concrete or grout and existing concrete will be exposed in finished work, remove concrete edge by making a 1 inch deep saw cut on each exposed surface of existing concrete or as indicated.

3.4 CONNECTION SURFACE PREPARATION

A. Concrete areas requiring patching, repairs, or modifications, prepare connection surfaces as specified, as indicated, or as directed by the Engineer.

B. Remove loose and deteriorated materials, efflorescence, existing repair materials, dirt, oil, grease, and other bond inhibiting materials from concrete surface by dry mechanical means such as sandblasting, chipping, wire brushing, or other mechanical means as approved by the Engineer.

1. Uniformly roughen concrete surface to approximately 1/4 inch amplitude with pointed chipping tools. Thoroughly clean surface of loose or weakened material by sandblasting or air-blasting.

2. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.

C. If reinforcing steel is exposed, mechanically clean to remove loose material, contaminants, and rust as approved by the Engineer. If half of reinforcing steel diameter is exposed, chip out behind the steel. Chip distance behind the steel to a minimum of 1 inch. Do not damage reinforcing to be incorporated in new concrete or repair mortar during removal operation.

D. Clean reinforcing from existing removed or deteriorated concrete that is shown to be incorporated in new concrete or repair mortar by mechanical means to remove loose material and products of corrosion before proceeding. Cut, bend, or lap to new reinforcing as indicated and provide with 1 inch minimum clear cover.

E. Use following specific concrete surface preparation Methods where indicated, specified, or as directed by the Engineer:

1. Method A:

    a. Roughen and clean existing concrete surface at connection.
    b. Thoroughly saturate surfaces with water; prevent standing water during application.
    c. Scrub cement paste (cement and water mixed to consistency of a thick paste) into substrate filling concrete pores and voids.
    d. Place new concrete against scrub coat of cement paste while cement paste is still plastic.

2. Method B:

    a. Roughen and clean existing concrete surface at connection.
    b. Apply epoxy bonding agent at connection surfaces.
    c. Place new concrete or grout mixture to limits indicated within time constraints recommended by manufacturer to ensure bond.

3. Method C:

    a. Use adhesive anchoring system, as specified in Section 050519 “Post-Installed Anchors”, for installation of reinforcing steel dowels into existing concrete where indicated.
    b. Perform installation complying strictly with manufacturer's recommendations, including drill bit diameter, surface preparation, injection, and installation of dowels.
    c. Drill concrete to embedded deformed bars to indicated depths.
    d. Use oil-free compressed air to blast out loose particles and dust from drilled holes. Clean dowels to be free of dirt, oil, grease, ice, or other deleterious material that would reduce bond.
    e. Concrete in existing structures is considered to have a strength of 3,000 psi.

4. Method D:

    a. Combination of Method B & Method C.

3.5 GROUTING

A. Grout: As specified in Section 03600 “Grouting.”

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed installations.

1. Perform inspection with Contractor, material installer, and the Engineer present. Give minimum of 72 hours’ notice prior to time of inspection.
2. Repair modifications not in conformance with Contract Documents in accordance with manufacturer's instructions at no additional cost to Owner.
3. At completion of non-conforming repairs, Contractor, material installer, and the Engineer shall reinspect the repaired problem areas.
4. Prepare inspection reports, identifying acceptable work, type and locations of unacceptable work, and actions taken to correct unacceptable work.
5. Complete field quality control work without additional compensation.

END OF SECTION 03015

THIS PAGE INTENTIONALLY LEFT BLANK.

SECTION 03303 – CAST-IN-PLACE CONCRETE AND 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 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 03600 “Grouting” for grouting.
2. Section 05051 “Post-Installed Anchors” for post installed adhesive anchoring system.
3. Section 02300 "Earthwork" for drainage fill under slabs-on-grade.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with fly ash or ground granulated blast furnace slag; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Concrete Design Mixtures: Design Mixtures: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard (cubic meter), water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash or ground granulated blast furnace slag. Provide either:

1. Standard deviation data for each proposed concrete mix based on statistical records.
2. Water cementitious ratio curve for concrete mixes based on laboratory tests.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, spacing, lengths, material, grade, bar schedules, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, and supports for concrete reinforcement. Reference bars to be the same identification marks shown on the bar bending details.

D. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Curing compounds.
6. Bonding agents.

E. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates**:** Conformance to ASTM standards, including sieve analysis, mechanical properties, and deleterious substance content, and mortar bar expansion test results, proof that the aggregate non-reactive.
2. Mill Test Reports: Conformance to ASTM standards, including chemical analysis and physical tests.

    a. Cementitious materials.
    b. Steel Reinforcing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For independent testing agency responsible for concrete design mixtures.

B. Certifications:

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certificate of conformance for concrete production facilities from the NRMCA.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter that will reduce or destroy bond. Deliver, store, and handle steel reinforcement to prevent bending and damage. Store reinforcement off the ground, protect from moisture, and keep out of standing water, and free from rust, mud, dirt, grease, oil, ice, or other contaminants and deleterious matter that will reduce or destroy bond.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer’s recommended storage time, whichever is less.

D. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location.
2. Provide additional protection according to manufacturer instructions.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average of the highest and lowest temperature from midnight to midnight is expected to fall below 40 deg F for three successive days, maintain delivered concrete temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 117.

2.2 FORM-FACING MATERIALS

A. Surface Finish 2.0 Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

C. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Form-release agent to comply with Federal, State and local VOC limitations.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

D. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete, heavy high frequency vibration of the concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to retaining walls.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, new deformed bars.

B. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.

2.4 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete of greater compressive strength than the specified concrete strength, according to CRSI's "Manual of Standard Practice," and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

B. Tie wires for reinforcement: 16 gauge or heavier black annealed wire to tie uncoated reinforcing.

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type II.
2. Fly Ash: ASTM C618, Class F.
3. Ground Granulated Blast Furnace Slag: ASTM C989/C989M, Grade 100 or 120.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: As indicated by concrete mixtures specified herein.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

F. Water: ASTM C94/C94M and potable.

2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1-D, Class B, dissipating.

2.7 RELATED MATERIALS

A. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types V, load bearing, for bonding freshly mixed concrete to hardened concrete.

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: limit percentage, by weight, of cementitious materials (Portland cement alone or in combination with fly ash or Ground Granulated Blast Furnace Slag) in concrete as follows:

1. Fly Ash: 25 percent.
2. Ground Granulated Blast Furnace Slag: 50 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete, for placement and workability.
2. High-range water-reducing admixture in concrete, may be used, for placement and workability.

2.9 CONCRETE MIXTURES

A. Concrete Fill and Electrical Raceway Encasement:

1. Minimum Compressive Strength: 2500 psi at 28 days.
2. Maximum W/C Ratio: 0.62.
3. Slump Limit: 3 inches plus or minus 1 inch.
4. Air Content: 6.0 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Coarse Aggregate: ASTM C33, size.
6. Dye Color:

    a. Red-oxide coloring pigment for electrical raceway encasement.
    b. No pigment for concrete fill.

B. Structural Concrete:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.42.
3. Slump Limit: 4 inches], 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 6.0 percent, plus or minus 1.5 percent at point of delivery.
5. Coarse Aggregate: ASTM C33, size 57.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Erect, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Use form-facing materials as required to meet the surface finishes (SF) requirements of ACI 301, unless otherwise specified provide as-cast form finishes per ACI 301 as follows.

1. Surface Finish (SF-2.0).

D. Construct forms tight to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where necessary. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, ice, snow and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations must be maintained.

1. Leave formwork for structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are not acceptable for exposed surfaces. Re-apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose mill scale, rust, mud, dirt, grease, oil, ice, and other foreign materials that reduce or destroy the bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum clear concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Splicing:

1. Lengths of splices as indicated on the Drawings.
2. If not indicated on Drawings, locate reinforcement splices at point of minimum stress.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Locate joints for foundations in the middle third of spans.
3. Locate horizontal joints in walls and at the top of footings.
4. Space vertical joints in walls as indicated on the Drawings.
5. At construction joints and at concrete joints indicated on Drawings to be "roughened", uniformly roughen the surface of concrete to a full amplitude (distance between high and low points and side to side) of 1/4 inch with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Coat surfaces to a depth of at least 1/8 inch thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.
6. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

3.6 PREPARATION

A. Dye Color:

1. Dye concrete red throughout by adding coloring pigment to mix during batching. Surface treatment will not be accepted.

2. Colorant Proportion: 8 lbs. of integral pigment per cu.yd. of concrete.
3. Costs, if any, for cleaning coloring pigment due to concrete delivery, handling, equipment, and other related cleanings shall be considered as part of base work scope.

    a. Replace adjacent surfaces that cannot be cleaned of red dye with new materials without additional compensation.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid “cold” joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
4. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

D. Slabs and equipment foundations:

1. Maintain reinforcement in position on chairs during concrete placement.
2. Screed surfaces with a straightedge and strike off to correct elevations.
3. Slope surfaces uniformly to drains where required.
4. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.8 FINISHING SURFACES

A. Finish concrete surfaces according to ACI 301.

B. Surface Finish 2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to view,.

C. Rubbed Finish: Apply a Smooth-Rubbed Finish per ACI 301 to exposed Surface Finish 2.0 as-cast vertical concrete surfaces as specified.

D. Float Finish: Apply float finish per ACI 301 prior to broom finish or trowel finish.

E. Broom Finish: After concrete has received a float finish, apply to smooth-formed-finished as-cast concrete exterior surfaces subject to pedestrian traffic. Provide broom finish perpendicular to direction of pedestrian traffic.

F. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and chamfers.

C. Equipment Pads:

1. Coordinate sizes and locations of concrete pads with actual equipment provided.
2. Install reinforcing dowels; to connect concrete pad to concrete floor, unless otherwise indicated.
3. For supported equipment, install anchor bolts that extend through concrete pad and anchor into structural concrete substrate.
4. Prior to placing concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Cast anchor-bolt insert into pads. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

B. Formed Surfaces: Cure formed concrete surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repair surfaces containing defects. Surface defects include color and texture irregularities, voids, cracks, spalls, air bubbles, bug holes, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

D. Limit sawcut at the perimeter of the area to a depth of 3/4 inch. Make edges of cuts perpendicular to concrete surface. Prepare surfaces per patching mortar manufacturer’s recommendations.

E. Repairing Formed Surfaces:

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects using patching mortar. On surfaces exposed to view repair by blending white Portland cement and standard Portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

F. Repairing Unformed Surfaces:

1. Inspect unformed surfaces, such as tops of foundations or equipment pads, for finish and verify surface tolerances specified for each surface.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Limit sawcut at the perimeter of the area to a depth of 3/4 inch. Finish repaired areas to blend into adjacent concrete.
4. Repair defective areas, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Mix patching mortar per manufacturer’s recommendations, including coarse aggregate when required. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
5. Correct crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

G. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

H. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.12 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing and inspection agency to perform field tests and inspections and prepare test reports.

B. Notify the Owner when the reinforcing is complete and ready for inspection, at least six working hours prior to the proposed concrete placement. Do not cover reinforcing steel with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the Owner’s inspection agency and the Owner’s inspection agency release to proceed with the concreting has been obtained. Keep forms open until the Owner’s inspection agency has completed inspection of the reinforcement.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements by the Owner’s testing agency:

1. Testing Frequency: One composite sample for each day's placement of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: One composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C143/C143M; one test at point of discharge for each composite sample, but not less than one test for each day's placement of each concrete mixture. Additional tests will be performed when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M, pressure method, for concrete; one test for each composite sample at the point of placement, but not less than one test for each day's placement of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M.

    a. Cast and cure one set of five 6 inch x 12 inch long standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at 7 days, test one specimen at 14 days, test two specimens at 28 days. The fifth may be used to verify strength after 28 days if the 28-day test results are low.
8. Strength of each concrete mixture will be satisfactory if every average of any three-consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03303

SECTION 03600 - GROUTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Portland cement grout.
2. Cement grout.
3. Rapid-curing epoxy grout.
4. Nonshrink epoxy grout.
5. Nonshrink cementitious grout.

B. Related Requirements:

1. Section 03303 “Cast-in-Place Concrete and Reinforcing.”
2. Section 05502 “Metal Fabrications” for grout related to miscellaneous metals.

1.3 ACTION SUBMITTALS

A. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.

1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing nonshrink grouts.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

A. Perform Work according to the Manufacturer’s standards.

B. Maintain one copy of each standard affecting Work of this Section on Site.

C. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.

D. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer’s recommended storage time, whichever is less.

C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location.
2. Provide additional protection according to manufacturer instructions.

1.7 AMBIENT CONDITIONS

A. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.

B. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 NONSHRINK CEMENTITIOUS GROUT

A. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.

3. No shrinkage when tested in conformity with ASTM C827/C827M.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C1107/C1107M for Grades B, C, D and CRD-C621 nonshrink grout:

a. Setting Time:

1) Initial: Approximately two hours.
2) Final: Approximately three hours.
3) Comply with ASTM C191.

b. Maximum Expansion: 0.10 to 0.40 percent.
c. Minimum Compressive Strength:

1) One-Day: 4,000 psi.
2) Seven-Day: 7,000 psi.
3) 28-Day: 10,000 to 10,800 psi.
4) Comply with CRD-C621.

2.2 FORMWORK

A. As specified in this Section and in Section 03303 “Cast-in-Place Concrete and Reinforcing”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to receive grout.

3.2 PREPARATION

A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by Engineer.

B. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints, and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

C. Roughen concrete lightly, but not to interfere with placement of grout.

D. Remove foreign materials from metal surfaces in contact with grout.

E. Align, level, and maintain final positioning of components to be grouted.

F. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, or flooding the surface or other method acceptable to Engineer. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.

G. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by Engineer. Grout voids created by the removal of shims, wedges, and blocks.

3.3 INSTALLATION - GENERAL

A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 03303 “Cast-in-Place Concrete and Reinforcing”.

B. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

C. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

D. Reflect existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

3.4 SCHEDULE

A. Use particular types of grout as follows:

1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.
2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long. Use at locations indicated to receive flowable (precision) nonshrink grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.

END OF SECTION 03600

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 04220 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grout.
2. Steel reinforcing bars.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Grout mixes. Include description of type and proportions of ingredients.
2. Reinforcing bars.

C. Mix Designs: For each type of grout. Include description of type and proportions of ingredients.

1. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

1.7 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Grout: ASTM C404.

E. Water: Potable.

2.2 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.3 GROUT MIXES

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

1. Do not use calcium chloride in grout.

B. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1.
3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

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

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 48 inches.

3.4 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.5 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04220

THIS PAGE INTENTINALLY LEFT BLANK.

SECTION 05051 - POST-INSTALLED ANCHORS AND REINFORCING BARS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Post-installed adhesive and expansion anchors for concrete and concrete masonry unit substrates.
2. Post-installed reinforcing bar dowels using adhesive anchoring system.

B. Related Requirements:

1. Section 03303 “Cast-In-Place Concrete and Reinforcing” and related Sections for concrete, reinforcement, and accessories.
2. Section 04220 “Unit Masonry” for concrete masonry units and accessories.

1.3 ACTION SUBMITTALS

A. Post-Installed Expansion Anchors:

1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics for expansion anchors.
2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed expansion anchors installed into cracked concrete masonry.
3. Installation Procedures: Submit procedures stating product proposed for use, and complete installation method.

B. Post-Installed Adhesive Anchoring System:

1. Design Data: Submit manufacturer’s specifications and data including recommended design values and physical characteristics, including temperature, humidity, and moisture limitations for adhesive anchoring system.
2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed adhesive anchoring system installed into cracked concrete masonry.
3. Installation Procedures: Submit procedures stating method of drilling, product proposed for use, and complete installation method.

1.4 INFORMATIONAL SUBMITTALS

A. Installation procedure: Submit installation procedure for post-installed adhesive anchoring system; including method of drilling.

B. Certificates:

1. Installer Qualifications for Adhesive Anchoring System: Submit installer and testing agency qualifications as stated in following Paragraph of this Article.
2. Submit current International Code Council (ICC) Evaluation Service Reports (ESR) for expansion anchors and adhesive anchoring system, for installation into cracked concrete or masonry, as applicable, indicating conformance with current ICC Evaluation Service (ICC-ES) Acceptance Criteria.

C. Qualification Data:

1. Installer: Indicate manufacturer's training date and a list of personnel trained on installation of adhesive anchoring system.
2. Testing Agency:

a. Laboratory: Meet requirements of ASTM E329. Prior to testing, submit qualifications of proposed testing laboratory for approval that includes:

1) Name and address.
2) Names and positions of principal officers and name, position, and qualifications of responsible registered professional engineer in charge.
3) List technical services provided, indicating external technical services to be provided by other organizations.
4) Names and qualifications of the supervising laboratory technicians.
5) Provide report prepared by laboratory evaluations authority when requested by The Engineer.
6) Submit as required above for other organizations that will provide external technical services.

b. Include in submittal a list of five projects in which the laboratory has performed testing in accordance with ASTM E488. Include following information for each project:

1) Project name and location.
2) Project Owner.
3) Owner's representative including address and phone number.
4) Brief description of work.

3. Submit qualifications of other laboratory or laboratories until approved.

D. Evaluation Reports: From ICC-ES for expansion anchors and adhesive anchoring system, for installation of post-installed anchors into cracked concrete or concrete masonry unit, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.5 QUALITY ASSURANCE

A. General: Coordinate with the work of other Sections, field verifying dimensions and work of other trades adjoining items of work before installing items specified in this Section.

B. Adhesive Anchoring System:

1. Installer Training: Conduct thorough training by the manufacturer or the manufacturer's representative. Training shall consist of the complete installation process for post-installed anchors and reinforcing bar dowels, including but not limited to:

    a. Tool selection.
    b. Hole drilling procedure.
    c. Hole preparation and cleaning techniques.
    d. Adhesive injection technique and dispenser training and maintenance.
    e. Anchor preparation and installation.
    f. Reinforcing bar dowels preparation and installation.
    g. Proof loading and torqueing.
    h. Temperature, humidity, and moisture limitations.
    i. Working time limitations.
    j. Setting time.

2. Include training for anchors and reinforcing bar dowels installed horizontally or upwardly inclined to support sustained tension loads. Install horizontally or upwardly inclined anchors and reinforcing bar dowels by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
3. Manufacturer's Certificate of Proper Installation: Submit upon completion of work, for the post-installed anchors and reinforcing bar dowels, including non-production and production anchors and reinforcing bar dowels.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Handle materials with cranes or derricks. Do not dump material off transportation vehicles or handle in ways that will cause damage.

C. Store materials elevated above grade and block up so they will not become bent or otherwise damaged.

D. Repair items that have become damage or corroded to satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 EXPANSION ANCHORS

A. Fastening to Concrete Substrate: Zinc plated carbon steel wedge type anchors, complete with zinc plated nuts and washers, unless otherwise noted.

B. Submerged or Weather Exposed Substrates: ASTM A276 Type 316 stainless steel wedge type anchors, complete with Type 316 stainless steel nuts and washers, unless otherwise noted.

C. Meet ICC ES AC01 or ICC ES AC193.

D. Length: When length or anchor embedment is not indicated, provide length sufficient to place the wedge and expansion cone portion of the anchor at least 1 inchbehind concrete reinforcing steel.

E. Basis-of-Design:

1. Anchorage designs indicated are based on Hilti, Kwik-Bolt TZ, unless otherwise noted.
2. Acceptable Anchors: Hilti Kwik-Bolt TZ; Simpson Strong-Tie Strong Bolt 2 Wedge Anchor; DeWalt Power-Stud+ SD1 DeWalt Power-Stud+ SD6 for stainless steel; or equal.

2.2 ADHESIVE ANCHORING SYSTEM

A. Fastening to Concrete Substrate: Manufactured system consisting of post installed threaded rods, nuts, washers, other anchoring hardware, and chemical dispenser for installation in hammer drilled holes.

1. Anchors: Meet ICC ES AC308.
2. Injection Adhesive: Two-component epoxy system consisting of a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate.
3. Adhesive Cartridge: Side-by-side design to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
4. Anchor: Zinc plated carbon steel or Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.

    a. Basis-of-Design:

        1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
        2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

5. Reinforcing Bar Dowels: Reinforcing bar, per Section 033010.

    a. Basis-of-Design:

        1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
        2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

B. Fastening to Hollow Concrete Block, Brick, or Hollow-Core Precast Concrete Planks: Three-part threaded rod, screen tube, and chemical dispenser anchoring system.

1. Anchors: Meet ICC ES AC58.
2. Adhesive Cartridges: Contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser.
3. Anchor: Zinc plated carbon steel or Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.
4. Reinforcing Bar Dowel: Reinforcing bar, per Section 033010.
5. Basis-of-Design:

    a. Anchorage designs indicated are based on Hilti HIT HY-270 System, unless otherwise noted; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install anchoring system in strict compliance with manufacturer's published installation instructions and approved Shop Drawings. Comply with recommended surface preparation, temperature, and moisture of substrate and ambient conditions.
2. Coordinate installation with Special Inspector.
3. Use drill bit of correct diameter and drill to required depth using rotary impact type hammer drills with carbide-tipped bits.
4. Drill holes perpendicular to concrete surface, unless otherwise indicated.
5. Use oil free compressed air to blast out loose particles and dust from drilled holes.

B. Expansion anchors:

1. Check expansion anchors for tightness a minimum of 24 hours after initial installation.

C. Adhesive anchoring system:

1. Perform installation only by personnel trained in anchor installation and having certification required in PART 1 - GENERAL.
2. Inject adhesive and install anchors reinforcing bar dowels that are clean and free of dirt, oil, grease, ice or other deleterious material which would reduce bond.

END OF SECTION 050519

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 05502 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Steel beams.
4. Steel angles.
5. Steel closure plates.

B. Related Requirements:

1. Section 03303 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 03600 “Grouting” for non-shrink grout.
3. Section 04220 "Concrete Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
4. Section 05051 “Post-Installed Anchors and Reinforcing Bars” for anchors in various substrates.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous steel items.

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

1. Certify that welders have been qualified under AWS, within previous 12 months, to perform welds required under this Section.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless steel."

C. Evaluation Reports: Post-installed concrete anchors, from ICC-ES for adhesive anchor system, for installation into cracked concrete or unit masonry, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Wide Flange Shapes: ASTM A992.

C. Steel Other Shapes, Plates, Shapes, and Bars: ASTM A36/A36M.

D. Steel Tubing: ASTM A500/A500M, Grade B cold-formed steel tubing.

E. Steel Pipe: ASTM A53/A53M, Type S Grade B Standard Weight (Schedule 40) unless otherwise indicated.

F. Stainless steel Bolts: ASTM F593, Type 316.

G. Stainless steel Nuts: ASTM F594, Type 316.

H. Galvanizing: ASTM A123, Zn w/0.05 percent minimum Ni.

I. Galvanizing, hardware: ASTM A153, Zn w/0.05 percent minimum Ni.

J. Galvanizing, anchor bolts: ASTM F2329, Zn w/0.05 percent minimum Ni.

K. Welding electrodes, steel: AWS A5.1 E70xx.

2.2 FASTENERS

A. Unless otherwise noted, provide steel machine bolts for the connection of carbon steel or iron; galvanized steel or stainless-steel machine bolts for the connection of galvanized steel or iron; and stainless steel machine bolts for the connection of aluminum or stainless-steel.

B. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.
3. Provide stainless steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

D. Mechanically Galvanized Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM F3125, Grade A325, Type 3; with hex nuts, ASTM A563, Grade C3; and, where indicated, flat washers.

E. Stainless steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.

F. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Provide standard headed bolts with heavy hex nuts and Grade A washers.
2. Where galvanized anchor bolts are indicated or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, galvanize in accordance with ASTM F2329.

G. Machine bolts and nuts conforming to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.

H. Toggle Bolts: shall be Hilti, Toggler Bolt or equal.

I. Power-Actuated Fasteners for mounting HVAC equipment to steel: Hilti X-BT-MR stainless steel threaded studs, or equal.

2.3 MISCELLANEOUS STEEL

A. Miscellaneous Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal thread on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous Steel Items: Beams, angles, lintels, metal stairs detailed on the Drawings, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holddown straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel indicated and not otherwise specified.

D. Steel Finish Work: Thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter. Provide one shop coat of primer compatible with finish coat after fabrication but before shipment. Omit paint within 3 inches of proposed field welds. Apply paint to dry surfaces and be thoroughly and evenly spread and well worked into joints and other open spaces.

E. Galvanizing, where required: Use hot-dip zinc process after fabrication, coating not less than 2 oz/sq.ft. of surface.

2.4 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/4 by 1 inch, with a minimum 6 inch embedment and 1 1/2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

2.7 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products. Limit maximum nickel (Ni) content of galvanizing zinc to 0.05%.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 03 and Division 04 respectively. Install items to be attached to concrete

or masonry after such work is completed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

1. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding after welding.
2. Clean and repair, after installation, zinc coating which has been burned by welding, abraded, or otherwise damaged. Thoroughly clean damaged area and remove all traces of welding flux and loose or cracked zinc coating prior to painting. Paint the cleaned area per the requirements of ASTM A780.
3. Install specialty products in accordance with the manufacturer's recommendations.
4. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
5. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
6. Field Welding: Comply with the following requirements:
7. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
8. Obtain fusion without undercut or overlap.
9. Remove welding flux immediately.
10. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
11. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, , and other connectors.
12. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
13. Corrosion Protection: Coat concealed surfaces of steel that comes into contact with grout, concrete, masonry, or dissimilar metals with the following:

    a. Steel Contacting Exposed Concrete or Masonry: Apply heavy bitumastic troweling mastic.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780 .

END OF SECTION 05502

SECTION 09069 - PAINT COLOR SCHEDULE

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. Sections includes paint color schedule to indicate color and textures of paint to be provided.

B. Related Requirements:

1. Painting is included in Section 09967 “Atmospheric Protection and Plant Services Areas Coatings.”

1.3 ACTION SUBMITTALS

A. Samples: Submit the following for each type of coating system and in each color and gloss of finish coat indicated.

1. Color cards for initial color selections.
2. Three sets of 8-in by 8-in samples, on 1/4-in hardboard, of all colors required for all types of paint. Resubmit until approved.

1.4 PAINT COLOR SCHEDULE

ITEM	NUMBER/COLOR
BUILDING INTERIOR (existing and new unless otherwise noted)	
Existing concrete, CMU, and other walls surfaces where conduit has been removed	TBS
Other surfaces scheduled or noted to be painted or repainted.	TBS

ITEM	SIGNAGE	COLOR
HVAC: None		

ITEM	SIGNAGE	COLOR
PLUMBING: None		

ITEM	SIGNAGE	COLOR
MECHANICAL PIPING SYSTEMS: None		

ITEM	SIGNAGE	COLOR

PROCESS EQUIPMENT: None

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 09069

SECTION 09967 – ATMOSPHERIC PROTECTION AND PLANT SERVICE AREAS COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and application of high-performance coating systems for items indicated on the Drawings and in Section 09069 “Paint Color Schedule.”

1.3 DEFINITIONS

A. MPI Gloss Levels: Following define gloss levels according to ASTM D 523:

1. MPI Gloss Level 1 - Traditional Matte or Flat Finish: Maximum five units at 60 degrees and 10 units at 85 degrees.
2. MPI Gloss Level 2 - Velvet-Like Finish: Maximum 10 units at 60 degrees and 10 to 35 units at 85 degrees.
3. MPI Gloss Level 3 - Traditional Eggshell-Like Finish: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
4. MPI Gloss Level 4 - Satin-Like Finish: 20 to 35 units at 60 degrees and minimum 35 units at 85 degrees.
5. MPI Gloss Level 5 - Traditional Semi-Gloss Finish: 35 to 70 units at 60 degrees.
6. MPI Gloss Level 6 - Traditional Gloss: 70 to 85 units at 60 degrees.
7. MPI Gloss Level 7 - High Gloss: Minimum 85 units at 60 degrees.

B. Mild Exposure: Normal outdoor weathering and standard industrial exposures are considered mild environments. A normal industrial setting is one with low to moderate levels of humidity and condensation and little development of mold and mildew. A mild environment has only limited exposure to chemical fumes or mist, and occasional occurrences of chemical spills or splash. Regular cleaning with standard commercial chemical cleaning agents, with only occasional use of stronger chemical cleaning agents, is also characteristics of a mild environment. Metal corrosion will occur in a mild environment, but it is minimal. These are generally dry areas with little to no Hydrogen Sulfide (H2S), Chlorine, or other corrosive chemicals, or the area is damp.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Indicate VOC content.

B. Samples: For selection of each color and gloss of topcoat indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
3. Deliver materials on site in factory sealed containers from the manufacturer. Do not use materials from previous jobs.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are within the coatings manufacturer's recommendations.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point and rising; or to damp or wet surfaces.

C. Lead Paint: It is not expected that lead paint will be encountered in the Work.

1. If suspected lead paint is encountered, do not disturb; immediately notify Engineer and Owner.

D. Do not apply exterior coatings in snow, rain, fog, mist, and in conditions that do not meet the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carboline Company (CAR).
2. PPG Paints (PPG).
3. The Sherwin-Williams Company (SWC).
4. Tnemec Company, Inc. (TNE).

2.2 HIGH-PERFORMANCE COATINGS

A. Material Compatibility:

1. Each coating system within indicated substrates uses compatible material with one another, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. Topcoat manufacturer recommends products in writing for use in each coating system coat and on indicated substrate.
3. Use products from same manufacturer for each coat in coating system.

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

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, both coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. CMUs: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

1. Application of coating indicates acceptance of surfaces and conditions.
2. Recoating of Previously Coated Surfaces: Verify conditions and compatibility between new and existing high-performance coating products.

D. Proceed with coating application only after unsatisfactory conditions have been corrected. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be coated.

1. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
2. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed.
3. Remove surface-applied protection if any.

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

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

1. Concrete Floors: Remove oil, dust, grease, dirt, and other foreign materials. Comply with SSPC-SP-13/NACE 6 or ICRI 310.2R.
2. Abrasive blast clean surfaces to comply with SSPC-SP-13/NACE 6.

E. Masonry Substrates: Remove efflorescence and chalk.

1. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.
2. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi at 6 to 12 inches.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by manufacturer.

G. Galvanized-Steel Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

3.3 APPLICATION

A. Apply high-performance coatings in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

D. Film Thickness: Apply paint in wet film thickness (WFT) recommended by high-performance manufacturer to achieve specified dry film thickness (DFT) for each coat of paint. Since DFT varies among manufacturers, this reference is not included in Article "Atmospheric Protection Coating Schedule and Plant Service Areas Coating Schedule."

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

A. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.

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

3.6 ATMOSPHERIC PROTECTION COATING SCHEDULE

3.7 PLANT SERVICE AREAS COATING SCHEDULE

A. Miscellaneous Interior Process Support Areas, Non-submerged Surfaces, Mild Exposure:

1. Concrete Substrates:

a. Cross-linked, Water Based Epoxy System:

1) Prime Coat:

a) CAR: Sanitile 500.
b) PPG: Aquapon WB EP.
c) SWC: Loxon Conditioner.
d) TNE: Series 27WB.

2) Intermediate Coat:

a) CAR: Sanitile 500 VOC.
b) PPG: Aquapon WB EP.
c) SWC: Pro Industrial Wb Cat Epoxy.
d) TNE: Series 27WB.

3) Topcoat: (MPI Gloss Level 6).

a) CAR: Carboseal 555.
b) PPG: Aquapon WB EP.
c) SWC: Pro Industrial Wb Cat Epoxy.
d) TNE: Series 114.

2. Masonry Substrates:

a. Cross-linked, Water Based Epoxy System:

1) Prime Coat:

a) CAR: Sanitile 500.
b) PPG: 4-100XI.
c) SWC: Loxon Block Surfacer.
d) TNE: Series 1254.

2) Intermediate Coat:

a) CAR: Sanitile 500.
b) PPG: Aquapon WB EP.
c) SWC: Pro Industrial Wb Cat Epoxy.
d) TNE: Series 114.

3) Topcoat: (MPI Gloss Level 5 or 6).

a) CAR: Carboseal 555.
b) PPG: Aquapon WB EP.
c) SWC: Pro Industrial Wb Cat Epoxy.
d) TNE: Series 114.

3. Steel Substrates:

a. Polyamide Epoxy System:

1) Prime Coat:

a) CAR: Carboguard 60.
b) PPG: Amerlock 2.
c) SWC: Macropoxy 646 FC Epoxy.
d) TNE: Series 66.

2) Topcoat: (MPI Gloss Level 5).

a) CAR: Carboguard 635 VOC.
b) PPG: Amerlock 2.
c) SWC: Macropoxy 646 FC Epoxy.
d) TNE: Series 66.

4. Ductile Iron or Cast-Iron Substrates: Interior Atmospheric Pipe Exposure.

a. Epoxy System:

1) Prime Coat:

a) CAR: Carboguard 60.
b) PPG: Amerlock 2/400.
c) SWC: Macropoxy 646 FC Epoxy.
d) TNE: Series 66.

2) Topcoat: (MPI Gloss Level 5).

a) CAR: Carboguard 60.
b) PPG: Amerlock 2/400.
c) SWC: Macropoxy 646 FC Epoxy.
d) TNE: Series 66.

5. Galvanized Metal Substrates:

a. Epoxy System:

1) Prime Coat:

a) CAR: Carboguard 60.
b) PPG: Amerlock 2/400.
c) SWC: Macropoxy 646.
d) TNE: Series 66.

2) Topcoat: (MPI Gloss Level 5).

a) CAR: Carboguard 60.
b) PPG: Amerlock 2/400.
c) SWC: Macropoxy 646.
d) TNE: Series 66.

END OF SECTION 099679

SECTION 13300 - PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

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 process control system Input-Output (I/O) lists.

B. Related Requirements:
   1. Section 13610 “Process Control and Enterprise Management Systems General Provisions” for I/O list submittal requirements.

1.3 DEFINITIONS

A. Input/Output (I/O): Analog or digital field instrument signals to be received and interpreted by a PLC.

B. Programmable Logic Controller (PLC): A ruggedized programmable computer used for industrial automation.

1.4 ACTION SUBMITTALS

A. Process Controller Input/Output (I/O) Schedule
   1. Submit complete I/O schedule as specified in Section 13610 “Process Control and Enterprise Management Systems General Provisions.”
   2. An electronic copy of this I/O list can be requested from the Engineer for use in preparing the I/O list submittal.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Section 13610 “Process Control and Enterprise Management System General Provisions.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 13300

APPENDIX A
PROCESS CONTROLLER I/O SCHEDULE

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 13610 - PROCESS CONTROL AND ENTERPRISE MANAGEMENT SYSTEMS GENERAL PROVISIONS

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. The services of the Process Control System Supplier (PCSS) will be performed by the Owner.

B. Section includes procurement of the services of a PCSS to provide all materials, equipment, labor, and services required to achieve a fully integrated and operational system as specified herein, in “Related Requirements” under this Article, and in related drawings, except for those services and materials specifically noted.

C. Include auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, whether indicated on the Drawings or not.

D. All equipment and installations to satisfy applicable Federal, State and local codes. Refer to Electrical drawings for area classifications for Class and /Division ratings.

E. Use the equipment, instrument, and loop numbering scheme indicated on the Drawings and in the specifications in the development of the submittals. Do not deviate from or modify the numbering scheme.

F. Related Requirements:

1. Section 13612 “Process Control System Testing Contractor performs programming”.
2. Section 13300 “Process Control System Input-Output List”.
3. Section 13614 “Process Control Descriptions”.

1.3 DEFINITIONS

A. Process Control System Supplier (PCSS): The entity responsible for providing all materials, equipment, labor, and services required to achieve a fully integrated and operational control system.

B. Applications Engineering System Supplier (AESS): The entity who provides all programming, configuration, and related services for the control system equipment provided by the PCSS.

C. Maintenance of Plant Operations (MOPO): A construction plan which prevents or limits process disruptions during construction.

D. Leadership in Energy and Environmental Design (LEED): A green building certification indicating that a building was designed and constructed to be environmentally responsible and use resources efficiently.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site for the purpose of a preinstallation meeting.

B. Conduct a project kickoff coordination meeting within two weeks after submitting the Project Plan. The purpose of the meeting is to discuss the PCSS's Project Plan, to summarize the PCSS's understanding of the project; discuss any proposed substitutions or alternatives; schedule testing and delivery deadline dates; provide a forum to coordinate hardware and software related issues; and request any additional information required from the Owner. The meeting will last up to 4 hours.

C. Conduct a submittal review coordination meeting after the Hardware, Panel Drawing, and Loop Drawing Submittal package has been reviewed by the Engineer and returned to the PCSS. The purpose of this meeting is to review comments made on the submittal package; to refine scheduled deadline dates; coordinate equipment installation activities; and provide a forum for any further required coordination between the PCSS and AESS. The meeting will last up to 4 hours.

D. Monthly conference call coordination meetings with Engineer, Contractor, Vendors, as required prior to any field start-up or activity testing begins.

E. Schedule the mandatory coordination meetings as described herein. Hold the meetings at the Owner's designated location and include attendance by the Owner, the Engineer, the Contractor, the PCSS's Project Engineer, and the AESS Project Engineer, if applicable. Other Division 13 specifications may require additional meetings. Prepare and distribute an agenda for this meeting a minimum of one week before the scheduled meeting date. Schedule the meeting for a minimum of one week before the requested meeting date.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, mountings, and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of control equipment, control panels, and instrumentation as specified herein.
4. Include diagrams for power, signal, and control wiring.

C. Project Plan, Deviation List, and Schedule Submittal:

1. Submit, within 45 calendar days after Notice to Proceed, a Project plan. Submit for approval the Project Plan before further submittals are accepted. The Project Plan to contain the following:

    a. Overview of the proposed control system describing the understanding of the project work, a preliminary system architecture drawing, interfaces to other systems, schedule, startup, and coordination. Include a general discussion of startup, replacement of existing equipment with new,, approach to testing and other tasks as required by these specifications.
    b. Project personnel and organization including the PCSS project manager, project engineer, and lead project technicians. Include resumes of each of these individuals and specify in writing their commitment to this project. These do not need to be submitted again if already submitted in the Qualification submittal.
    c. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of, loop drawings, control system architecture and P&IDs.

2. Define Exceptions to the Specifications or Drawings in a Deviation List consisting of a paragraph-by-paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. Specifically state if no exceptions are taken to the specifications or drawings. If there is no statement by the PCSS, then it is acknowledged that no exceptions are taken.
3. The PCSS must coordinate their work with the General Contractor’s overall schedule. PCSS schedule incorporates all PCSS milestones including but not limited to the following:

    a. Schedule for all subsequent project submittals. Include the time required for Contractor’s submittal preparation, Engineer's review time, and a minimum of two complete review cycles.
    b. Proposed dates for all project coordination meetings.
    c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
    d. Shipment of instrument and control system equipment.
    e. Installation of instrument and control system equipment.
    f. Testing: Schedule for all testing.
    g. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI server/workstation provided under this Contract.
    h. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.

4. Component and Wiring Identification and Tagging Plan:

    a. All components provided by PCSS require a tag, label, or nameplate. Review specifications and provide a plan indicating the tagging and labeling scheme used by the PCSS:

        1) Panel Hardware.
        2) Wires and communication cables.

    b. Provide detailed information so Engineer can review the following characteristics for each type of tag, label, or nameplate for the different types of components provided above:

        1) Size or range of size of the tag, label or nameplate.
        2) Font style.
        3) Material.
        4) Color(s).

D. Input/Output (I/O) List Submittal:

1. Submit, within 60 days after Notice to Proceed, a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
2. Base the I/O list on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
3. Submit the I/O list in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy.
4. Reflect all active and spare I/O points on the I/O list. Add points to accommodate spare I/O's as required in the specifications.
5. Arrange the I/O list so that each control panel has a dedicated worksheet, which includes the following information:

    a. TAG NUMBER(S): As indicated on the Drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, break out the tag loop number to allow for sorting by loop.
    b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
    c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
    d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
    e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO - Pulse Output.
    f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or the state at which the value of the discrete points is "1."
    g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
    h. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.

i. P&ID - the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
j. EXISTING or NEW I/O POINT: Indicate if point is existing (E) or new (N).

6. Sort the I/O list in order by:

a. Physical location.
b. I/O Type.
c. Loop Number.
d. Device Tag.

7. Once the I/O list is approved, the PLC I/O addresses are not modified without approval by the Engineer.

E. Panel Layout Drawings and Wiring Diagrams Submittal:

1. Panel Layout Drawings: Not required.
2. Wiring Diagrams Submittal:

a. PCSS to provide complete wiring diagrams showing all wiring connections in the I/O system where direct hardwired interfaces exist between the PCSS control panels and vendor provided control panels furnished under other Divisions. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. Include drawings in Final O&M submittal. Leaving this information blank on Final Documentation drawings is not acceptable.
b. Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. If ISA Loop Wiring Diagrams are specified below, equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring includes the device ISA-tag and a unique numeric identifier. Diagrams identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the PCSS. Wiring labeling used on the drawings match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. I/O wiring numbered with rack number, slot number, and point number. Two-wire and four-wire equipment to be clearly identified, and power sources noted. Submit final wire numbering scheme. Provide panel drawings that are 11-inch x 17-inch in size.
c. ISA Loop Wiring Diagrams: Not required.

F. Testing Plan Submittals:

1. Refer to Section 13612 “Process Control System Testing” for specific testing submittal requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all PCSS supplied hardware to include in operation and maintenance manuals.

1. Submit in accordance with Section 01782 “Operation and Maintenance Data.”
2. Include the following information on the operations and maintenance manuals:

a. Table of Contents:

1) Provide a Table of Contents for the entire manual with the specific contents of each volume clearly listed. Include the complete Table of Contents in each volume.

b. As-Built Drawings:

1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. Include on the drawings all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS. Provide electronic files for all drawings produced. Provide drawings in AutoCAD ".dwg" format and in Adobe Acrobat format. Provide drawings using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
2) Include on as-built documentation information from submittals, as described in this Specification, updated to reflect the as-built system. Incorporate errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests.

B. Electronic O&M Information:

1. In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on DVD. Supply electronic documents in Adobe Acrobat format.
2. Provide electronic files for all custom-developed manuals including training manuals. Supply text in Microsoft Office and Adobe Acrobat formats.
3. Provide electronic files for all drawings produced. Supply drawings in AutoCAD ".dwg" and in Adobe Acrobat formats. Provide drawings using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
4. Back up each computer system hardware device onto DVD after Substantial Completion and turn over to the Owner.
5. If specified in the training section, provide digital copies of all training videos. Format videos so they are readable by standard DVD players, a minimum of 800 by 600 pixels, and include sound.

C. Include information as specified in Section 01782 ”Operation and Maintenance Data” on the cover and edge of each volume.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Not required.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 01600 "Product Requirements" for delivery, storage, and handling requirements.

1.9 FIELD CONDITIONS

A. Environmental Requirements: Refer to Electrical Drawings for specific environmental and hazardous area classifications.

B. Elevation: Design equipment to operate at the project ground elevation.

C. Temperature:

1. Outdoor area equipment to operate between -4 to 122 degrees Fambient.
2. Equipment in indoor locations operate between 50 to 95 degrees F ambient minimum.
3. Storage temperatures range from 32 to 122 degrees F ambient minimum.
4. Furnish additional cooling or heating if required by the equipment specified herein.
5. Relative Humidity. Air-conditioned area equipment operates between 20 to 95 percent relative, non-condensing humidity. All other equipment operates between 5 to 100 percent relative, condensing humidity.

D. Do not ship control system equipment located in the control room until the control room areas comply with specified ambient temperature and humidity and free of dust and debris.

1.10 WARRANTY

1. Warranty Period: One (1) year from date of Substantial Completion unless noted otherwise in individual specification sections.

PART 2 - PRODUCTS

2.1 GENERAL

A. Electrical Requirements for Control System:

1. Operate equipment on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above to be provided between power supply and interconnected instrument loop. Supply constant voltage transformers where equipment requires voltage regulation.
2. With the exception for field device network connected devices, all electronic instrumentation utilize linear transmission signals of isolated 4 to 20 mA DC

(milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).

3. Outputs of equipment that are not of the standard signals as outlined, have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
4. All switches have double-pole, double-throw (DPDT) contacts rated at a minimum of 600 VA, unless noted otherwise.
5. Switches and/or signals indicating an alarm, failure or upset condition wired in a fail-safe manner as indicated on the I/O list. A fail-safe condition is when an open circuit generates an alarm state (i.e. contact opens).
6. Materials and equipment UL approved whenever such approved equipment and materials are available.
7. All equipment furnished designed and constructed so that in the event of power interruption, the systems specified all go through an orderly shutdown with no loss of memory and resume normal operation without manual resetting when power is restored, unless otherwise noted.
8. Surge protection requirements for control system power, signal, and communication lines are specified in Section 407856 “Isolators, Intrinsically Safe Barriers, and Surge Suppressors.”

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The shield on each process instrumentation cable to be continuous from source to destination and be grounded at only one ground point for each shield.

B. Provide sunshades for equipment mounted outdoors in direct sunlight. Include sunshades standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North to minimize the impact of glare and ultraviolet exposure on digital readouts.

3.2 IDENTIFICATION

A. Provide identification system for all PCSS provided hardware, instrumentation, and communication cabling.

3.3 FIELD QUALITY CONTROL

A. Refer to individual hardware and instrument specification sections.

3.4 STARTUP SERVICE

A. Refer to Section 13612 “Process Control System Testing.”

B. Engage a factory-authorized service representative to perform startup service as specified in individual hardware and instrument specification sections.

C. Weekly on-site coordination meetings with Engineer, Contractor, Vendors as required during active construction period.

END OF SECTION 13610

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 13612 - PROCESS CONTROL SYSTEM TESTING

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 process control system testing, where the Applications Engineering services are performed by the Owner.

B. The services of the Process Control System Supplier (PCSS) will be performed by the Owner.

C. Related Requirements:

1. Section 01110 “Summary of Work.”
2. Section 13300 “Process Control System Input-Output List”.
3. Section 13610 “Process Control and Enterprise Management Systems General Provisions.”
4. Section 13614 “Process Control Descriptions”.

D. Furnish all labor, materials, equipment and incidentals required to complete the testing of all devices and systems furnished and installed as detailed on Drawings, and as specified herein.

1.3 DEFINITIONS

A. Process Control System Supplier (PCSS): The entity responsible for providing all materials, equipment, labor, and services required to achieve a fully integrated and operational control system.

B. Applications Engineering System Supplier (AESS): The entity who provides all programming, configuration, and related services for the control system equipment provided by the PCSS.

C. Human Machine Interface (HMI): A software-based user interface with supervisory level control and of machine level equipment.

D. Operator Interface Terminal (OIT): A hardware component of the HMI used for device level control and monitoring.

E. Programmable Logic Controller (PLC): A ruggedized programmable computer used for industrial automation.

F. Input/Output (I/O): Analog or digital field instrument signals to be received and interpreted by a PLC.

G. Uninterruptible Power Supply (UPS): A device capable of providing emergency battery power when the main power source fails.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Refer to Section 13610 “Process Control and Enterprise Management Systems General Provisions.”

1.5 ACTION SUBMITTALS

A. Refer to Section 13610 “Process Control and Enterprise Management Systems General Provisions.”

B. Testing Submittals - Submit, in one submittal, the following testing related documents:

1. Status signoff forms:

a. Develop and submit project specific I/O Status and Automatic Control Strategy signoff forms to be used during factory and field testing to organize and track each loop's inspection, adjustment, calibration, configuration, and testing status and sign off. Include sign-off forms for each testing phase showing all loops.

1) Example forms are shown in the Appendices.
2) Separate forms for factory and field testing can be used, or they can be combined, at the discretion of the PCSS.
3) Submit testing forms prior to start of testing.

1. Testing Procedures:

a. Submit detailed procedures proposed to be followed for each of the tests specified herein. The test procedures serve as the basis for the execution of the required tests to demonstrate that the system meets and functions as specified. At a minimum, provide the following test procedures:

1) Network and Communications Testing.
2) I/O Testing.
3) Control panel power, indictors, and hardwired logic tests.
4) Switchboard with Generator Testing.
5) Motor/Pump Control Testing.
6) HVAC Equipment and Equipment Control Testing.

b. Structure documents in an orderly and easy to follow manner to facilitate an efficient and comprehensive test.
c. Indicate in test procedures all pre-testing setup requirements, all required test equipment, and simulation techniques to be used.
d. Structure test procedures in a cause and effect manner where the inputs are indicated, and the outputs are recorded.

e. Include in test procedures the demonstration and validation under normal operating conditions and under various failure scenarios as specified in Contract Documents.
f. Do not start testing until all Testing Submittals have been approved.

C. Test Documentation:

1. Upon completion of each required test, document the test by submitting a copy of the signed off Testing Status forms. Testing is not considered complete until the signed-off forms have been submitted and approved. Submittals of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

1.6 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For Test Documentation of system:

1. Upon completion of each required test, document the test by submitting a copy of the signed-off Testing Status forms. Testing is not considered complete until the signed-off forms are submitted and approved. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

1.7 CLOSEOUT SUBMITTALS

A. Refer to Section 13610 “Process Control and Enterprise Management System General Provisions.”

1.8 COST OF TRAVEL

A. Scheduled tests will only be attended once by Engineer /Owner. If test is not successful, all subsequent tests will be performed at Contractor's expense. Reimburse Owner for all costs, including labor and expenses, invoiced by Engineer and incurred by Owner for subsequent retests.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING - GENERAL

A. Refer to Section 13610 “Process Control and Enterprise Management System General Provisions.”

B. Track results of all testing on a project specific status sign-off form or similar document. The PCSS is responsible for maintaining the sheet. Appendix of this Section has an example template for this sheet.

1. Field Testing:

    a. Operational Readiness Test (ORT).
    b. Functional Demonstration Test (FDT).
    c. Site Acceptance Test (SAT).

C. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide all special testing materials and equipment required for a suitable means of simulation.

D. PCSS to coordinate all required testing with Contractor, affected Subcontractors, Engineer, and Owner.

E. Do not ship equipment to jobsite until Engineer or Owner has received all Factory Testing results and approved the system as ready for shipment.

F. Engineer reserves the right to test or re-test any functions.

G. Correction of Deficiencies:

1. Correct deficiencies in workmanship and/or items not meeting specified testing requirements to meet specification requirements at no additional cost to Owner.
2. Repeat testing, as specified herein, after correction of deficiencies is made until specified requirements are met. Perform work at no additional cost to Owner.

3.2 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

A. Purpose of ORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test determines if equipment is ready for operation.

B. This test to take place prior to FDT and startup. Prior to starting this test, install relevant process equipment and mechanically test instruments installed, control panels installed, and field wiring complete.

C. Required Documents for Test:

1. Master copy of the PCSS developed field testing sign-off forms.
2. Testing procedures.
3. Calibration forms.

D. These inspections, calibrations, and tests do not require witnessing. However, Engineer may review and spot-check testing process periodically. All deficiencies found to be corrected by PCSS prior to commencement of Functional Demonstration Test.

E. PCSS to maintain Sign-off forms and Calibration forms at job site and make them available to Engineer/Owner at any time.

F. Perform the following tests as part of ORT:

1. Instrument calibration, configuration, and set-up.
2. Input/Output (I/O) Testing to HMI and OITs.
3. Testing of control strategies.

G. Instrument calibration, configuration, and set-up:

1. Calibrate, configure, and set-up all components and instruments to perform specified functions.
2. Calibration form:

    a. For any component or instrument requiring dip switch settings, calibration, or custom configuration, maintain a calibration form in field documenting this information. These forms provide a summary of the actual settings used in the field to allow an Instrument technician to replace the device entirely and configure it to function as it did before.
    b. Add this information to Instrument data sheet and to a copy of manufacturer's standard "Configuration Sheet" or create a separate form.

        1) If a separate form, list Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.

    c. Some examples of required information are:

        1) For Discrete Devices: Actual trip points and reset points.
        2) For Instruments: Any configuration or calibration settings entered into instrument.
        3) For Controllers: Mode settings (PID).
        4) For I/O Modules: Dip switch settings, module configuration (if not documented in native programming documentation).

    d. Maintain a copy of these forms in field during testing and make them available for inspection at any time.
    e. For any device that allows a software back-up of configuration files to a laptop, make configuration files available to Engineer/Owner for inspection. Submit as part of Final System Documentation as specified in Section 13610 "Process Control and Enterprise Management Systems General Provisions."

H. I/O Testing:

1. Purpose of I/O testing is to check that process equipment, instrument installation, calibration, configuration, field wiring, and control panels are set-up correctly to monitor and control the processes. This test is commonly referred to as a "loop test" or an I/O checkout.
2. PCSS in conjunction with Contractor to test signals under process conditions. Preferred test method will always be to execute test wherever possible to end elements. For example, preferred test will prove valve open/close limit switches by operating valve, not by installing a jumper on limit switch contacts. However, if equipment or process is not

available to test a signal over its entire calibrated range, PCSS may test using a simulation method and make a note on sign-off form.

3. Perform the following I/O tests:

    a. Discrete Input: At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within loop such as HMI screens, OIT screens, pilot lights, horns, beacons, etc.
    b. Analog Input: Test analog signal over entire engineering range at various intervals including 0, 50%, and 100% as well as on increasing and decreasing range. Observe results on all indicators within loop such as HMI screens, OIT screens, recorders, digital indicators, etc.
    c. Test discrete output signals by switching equipment to manual control at the HMI and OIT nodes and turning output on or using other means to turn output on. Then verify equipment responds accordingly.
    d. Test analog output signals by switching equipment to manual control at HMI and OIT nodes and turning output on or other means to turn output on. Then verify equipment responds accordingly.

I. Testing of Automatic Control Strategies:

1. Verify all automatic control strategies using actual process equipment and instruments, or other means, to verify logic performs as expected. Verify faults and logical failure scenarios for control strategies such as instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing for analog inputs, loss of power, and all other strategies specified in control strategy document.

J. Repeat all systems tests specified under factory testing.

K. Test UPS to verify UPS switch power correctly while keeping all UPS powered loads online. Also, test sizing of UPS by switching off-line power to UPS and verify if they maintain specified run time.

L. For all panels with enclosures modified by this Contract, test internal control panel temperature under full running conditions to ensure proper cooling/ventilation is being provided.

M. Upon successful completion of ORT, PCSS to submit a record copy of test results as specified in PART 1 and request scheduling of FDT.

3.3 FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)

A. After facility is started-up and running treatment process in automatic control to extent possible, perform a Functional Demonstration Test. Purpose of FDT is to allow Engineer or Owner representatives to witness actual functionality, performance, and stability of system while connected to process equipment.

B. Required Documents for Test:

1. Set of panel drawings and wiring diagrams from ORT with corrections noted.
2. Set of Contract Documents - all drawings and specifications.

3. All design-change related documentation.
4. Signed-off master copy of the PCSS developed field testing signoff forms.
5. Testing procedures.
6. Copy of completed calibration forms.
7. One copy of all O & M Manuals for PCSS supplied equipment.

C. Perform a witnessed FDT on each process area. To extent possible, repeat testing performed during ORT.

D. Follow specified daily schedule during factory tests and FDT.

E. After coordinating with Operations, perform a "Black Start" of the plant to confirm plant operation recovers as specified in Contract Documents. Black start means shutting off power to the plant and turning it back on. Perform separate tests by recovering the plant while on generator (if a generator is specified) and while on utility power.

F. Document punch list items and resolutions noted during test on Punch list/Resolution form. In event of rejection of any part or function test procedure, PCSS to perform repairs, replacement, and/or retest within 10 days.

G. Upon successful completion of the FDT, PCSS to submit a record copy of test results as specified in PART 1.

3.4 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

A. After completion of FDT, and system is started-up and running treatment process in automatic control to extent possible, perform a Site Acceptance Test.

B. While this test is proceeding, Engineer and Owner have full use of system. Only allow plant operating personnel to operate equipment associated with live plant processes. Plant operations remain the responsibility of Owner and decision of plant operators regarding plant operations are final.

C. During this test, PCSS personnel to be present as required to address any potential issues that would impact system operation. PCSS is expected to provide personnel for this test who have an intimate knowledge of hardware and software of system. When PCSS personnel are not on-site, PCSS to provide cell phone/pager numbers that Owner personnel can use to ensure that support staff is available by phone and/or on-site within four hours of a request by operations staff.

D. PCSS to analyze and correct any malfunctions during test. In event of rejection of any part or function, PCSS to perform repairs or replacement within 5 days.

E. Throughout duration of SAT, do not make software or hardware modifications to the system without prior approval from Owner or Engineer.

END OF SECTION 13612

APPENDIX 13**612-**A: EXAMPLE INPUT/OUTPUT (I/O) STATUS SIGN OFF FORM

An example template for I/O Status signoff form to be used for documenting testing results to Owner is attached. PCSS is required, prior to testing, to create a project specific I/O Status signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

APPENDIX 13**612-**B: EXAMPLE AUTOMATIC CONTROL STRATEGIES SIGN OFF FORM

An example template for Automatic Control Strategies signoff form to be used for documenting testing results to Owner is attached. PCSS is required, prior to testing, to create a project specific Automatic Control Strategies signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

4-Jun-14

[Project Name] Appendix A - Input/Output (I/O) Status Sign-Off Form

All Sections below are required to be filled out by PCSS as part of Field Testing.
Instrument Alarm Setpoint - Setpoint for any alarms set by PCSS
Wiring Complete - Signal wired from field device to PLC
I/O Tested - Signal tested from field device to SCADA HMI

PLC	Signal Tag	Description	Range or Active State when closed	P&ID	Signal	Rack	Slot	Channel	Instrument Alarm Setpoint	Calibrate, config., and Wiring complete	Date	PCSS I/O testing	Date	I/O Testing to the HMI	Date	Notes
PLC-SC	LIT-4000-1	Secondary Clarifier No. 1 Sludge Level	0-10 ft	8	AI	2	1	0								
PLC-SC	LIT-4010-3	Secondary Clarifier No. 3 Sludge Level	0-10 ft	8	AI	2	1	1								
PLC-SC	SI-4100-1	RAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1	2								
PLC-SC	SI-4100-4	RAS Pump No. 4 Speed Feedback	0-100%	15	AI	2	1	3								
PLC-SC	FIT-4102-1	RAS Flow Pumps 1-3	0-1900 GPM	14	AI	2	1	4								
PLC-SC	SI-4110-1	WAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1	5								
PLC-SC	N/A	Spare Slot	N/A	N/A	Spare	2	5	N/A								
PLC-SC	SC-4100-1	RAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7	0								
PLC-SC	SC-4100-2	RAS Pump No. 2 Speed Setpoint	0-100%	14	AO	2	7	1								
PLC-SC	SC-4100-3	RAS Pump No. 3 Speed Setpoint	0-100%	14	AO	2	7	2								
PLC-SC	SC-4110-1	WAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7	3								
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7	4								
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7	5								
PLC-SC	TSH-4000-1	Secondary Clarifier No. 1 High Temp	Normal	8	DI	3	1	0								
PLC-SC	XA-4000-1	Secondary Clarifier No. 1 Motor Overload	Normal	8	DI	3	1	1								
PLC-SC	WAH-4000-1	Secondary Clarifier No. 1 High Torque	Normal	8	DI	3	1	2								
PLC-SC	WAHH-4000-1	Secondary Clarifier No. 1 High High Torque	Normal	8	DI	3	1	3								
PLC-SC	YRI-4000-1	Secondary Clarifier No. 1 On/Off	On	8	DI	3	1	4								
PLC-SC	YCI-4000-1	Secondary Clarifier No. 1 In Remote	In Remote	8	DI	3	1	5								
PLC-SC	YFI-4100-1	RAS Pump No. 1 VFD Fault	Normal	14	DI	3	1	6								
PLC-SC	FAL-4100-1	RAS Pump No. 1 Low Flow	Normal	14	DI	3	1	7	50 GPM	RJM	12/18/2011	JAS	12/22/2011	MIC	12/29/2011	Example completed line
PLC-SC	Spare	Spare	Normal	14	DI	3	1	8								
PLC-SC	YRI-4100-1	RAS Pump No. 1 Running	Running	14	DI	3	1	9								
PLC-SC	YCI-4100-1	RAS Pump No. 1 In Remote	In Remote	14	DI	3	1	10								
PLC-SC	YFI-4110-1	WAS Pump No. 1 VFD Fault	Normal	14	DI	3	1	11								
PLC-SC	FAL-4110-1	WAS Pump No. 1 Low Flow	Normal	14	DI	3	1	12								
PLC-SC	Spare	Spare	Normal	14	DI	3	1	13								
PLC-SC	YRI-4110-1	WAS Pump No. 1 Running	Running	14	DI	3	1	14								
PLC-SC	YCI-4110-1	WAS Pump No. 1 In Remote	In Remote	14	DI	3	1	15								
PLC-SC	HSS-4000-2	Secondary Clarifier No. 2 Start Command	Start	8	DO	4	6	0								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	1								
PLC-SC	HSS-4100-2	RAS Pump No. 2 Start Command	Start	14	DO	4	6	2								
PLC-SC	HSS-7000-2	Sludge Holding tank Tank Blower No. 2 Start Command	Start	17	DO	4	6	3								
PLC-SC	HSS-4100-5	RAS Pump No. 5 Start Command	Start	15	DO	4	6	4								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	5								
PLC-SC	HSS-4105-1	Secondary Scum Pump No. 2 Start/Stop	Start	15	DO	4	6	6								
PLC-SC	HSS-4110-2	WAS Pump No. 2 Start/Stop Command	Start	15	DO	4	6	7								
PLC-SC	7160-FQI-1	Sludge Loadout LCP Pumping Indicator	Pumping	17	DO	4	6	8								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	9								
PLC-SC	HSS-7115-2	Sludge Holding Tank Mixer No. 2 Start	Start	17	DO	4	6	10								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	11								
PLC-SC	HSO-7117-2	Sludge Holding Tank Discharge Valve No. 2 Open CMD	Open	17	DO	4	6	12								
PLC-SC	HSC-7117-2	Sludge Holding Tank Discharge Valve No. 2 Close CMD	Close	17	DO	4	6	13								
PLC-SC	HSS-7120-2	TS Transfer Pump No. 2 Start Command	Start	17	DO	4	6	14								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	15								

EXAMPLE

4-Jun-14

[Project Name] Appendix B - Automatic Control Strategies Sign-Off Form

All Sections below are required to be filled out by PCSS as part of Testing

Auto. Control Strategies. - Loop operational in Automatic as defined in Control Stategies

Control Strategies Loop #	Control Strategy Description	P&ID	Auto. Control Strategy	Date	Notes
LOOP 281 - 284	LOW FLOW PUMPS	8			
LOOP 290	LOW EQ CHANNEL FLOW NO.4	8			
LOOP 300	MICROFILTRATION AIR SUPPLY LOW PRESSURE	10			
LOOP 351, 352	SITE LIFT STATION PUMP NO.1 AND NO. 2	12			
LOOP 355	SITE LIFT STATION HIGH AND LOW LEVEL CONTROL	12			
LOOP 371, 372	SLUDGE HOLDING TANK NO.1 AND NO. 2 LEVEL	14			
LOOP 381, 382	SLUDGE TRANSFER PUMPS	14			
LOOP 385	SLUDGE TRANSFER PUMPS REMOTE START/STOP COMMAND	14			
LOOP 700	EFFLUENT PUMPING STATION LEVEL	14			
LOOP 701, 702, 703	EFFLUENT PUMP NO.1	14			
LOOP 840	POST AERATION CHANNEL AIR FLOW CONTROL	15			
LOOP 900	SLUDGE TRANSFER PUMPS DISCHARGE FLOW	8			
LOOP 971	CENTRIFUGE SLUDGE FEED PUMP NO.1	8			
LOOP 1001	CENTRIFUGE NO.1 SLUDGE FEED FLOW CONTROL	8			
LOOP 1411, 1412	SODIUM HYPOCHLORITE STORAGE TANKS LEVEL	8			
LOOP 1421, 1422	SODIUM HYPOCHLORITE PUMPS	8			
LOOP 1430	SODIUM HYPOCHLORITE STORAGE TANKS CONTAINMENT AREA HIGH LEVEL DETECTION	14			
LOOP 2051, 2052, 2053	DIESEL ENGINE GENERATOR STATUS	14			
LOOP 2055	TRANSFER SWITCH STATUS	14			
LOOP 2060	GENERATOR KILOWATTS MONITORING	14			
APPENDIX ONE	EQUIPMENT RESTART DURING A POWER LOSS WITH THE GENERATOR RUNNING	14			
APPENDIX TWO	EQUIPMENT RESTART WITH POWER RESTORED AFTER A POWER LOSS	14			
N/A	SELF-HEALING CAPABILITIES OF NETWORK	N/A			
N/A	REDUNDANT SCADA SERVER FAILOVER AND RECOVERY	N/A			

SAMPLE

SECTION 13614 - PROCESS CONTROL DESCRIPTIONS

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. The services of the Process Control System Supplier (PCSS) will be performed by the Owner.

B. Section includes process control descriptions, where the Applications Engineering services are performed by the Owner.

C. Applications Engineer System Supplier (AESS) Programming Scope

1. Develop the control system applications to implement the process control descriptions for all new and existing systems. This Section is provided to define control strategies to be used for PLC programming of the system.
2. The Contract Documents are a single integrated document, and as such, all Drawings, Specifications Divisions and Specifications Sections apply. It is the responsibility of the Contractor and Subcontractors to review all Sections to ensure a complete and coordinated project.
3. The PCSS is cautioned to read this Section and all related Sections and their entirety prior to starting any programming. Many general control strategies and requirements are defined once in the body of this Section with the specific requirement called out in the individual control strategy. Implement these general strategies throughout this Contract unless specifically directed otherwise in the individual loop process control descriptions.
4. Follow loop and device tagging criteria shown on the Drawings without exception.
5. Establish programming approach and database/variable identification standards prior to performing any programming work. Review the proposed standards and conventions with the Owner.

D. Related Requirements:

1. Section 13610 “Process Control and Enterprise Management Systems General Provisions.”

1.3 DEFINITIONS

A. Applications Engineering System Supplier (AESS): The entity who provides all programming, configuration, and related services for the control system equipment provided by the PCSS.

B. Human Machine Interface (HMI): A software-based user interface with supervisory level control of machine level equipment.

C. Input/Output (I/O): Analog or digital field instrument signals to be received and interpreted by a PLC.

D. Operator Interface Terminal (OIT): A hardware component of the SCADA system used for device level control and monitoring.

E. Operator Workstation (OWS): A hardware component of the SCADA system used for supervisory level control and monitoring.

F. Process Control System Supplier (PCSS): The entity responsible for providing all materials, equipment, labor, and services required to achieve a fully integrated and operational control system.

G. Programmable Logic Controller (PLC): A ruggedized programmable computer used for industrial automation.

H. Supervisor Control and Data Acquisition (SCADA): Hardware and software components used for high-level supervisory monitoring of industrial processes. Typical devices that are part of the SCADA network include computers (OWS), PLCs, Ethernet switches, OITs, and HMIs.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Control System Hierarchy

1. The control descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. An example of multiple layered loop is shown in Figure 1.

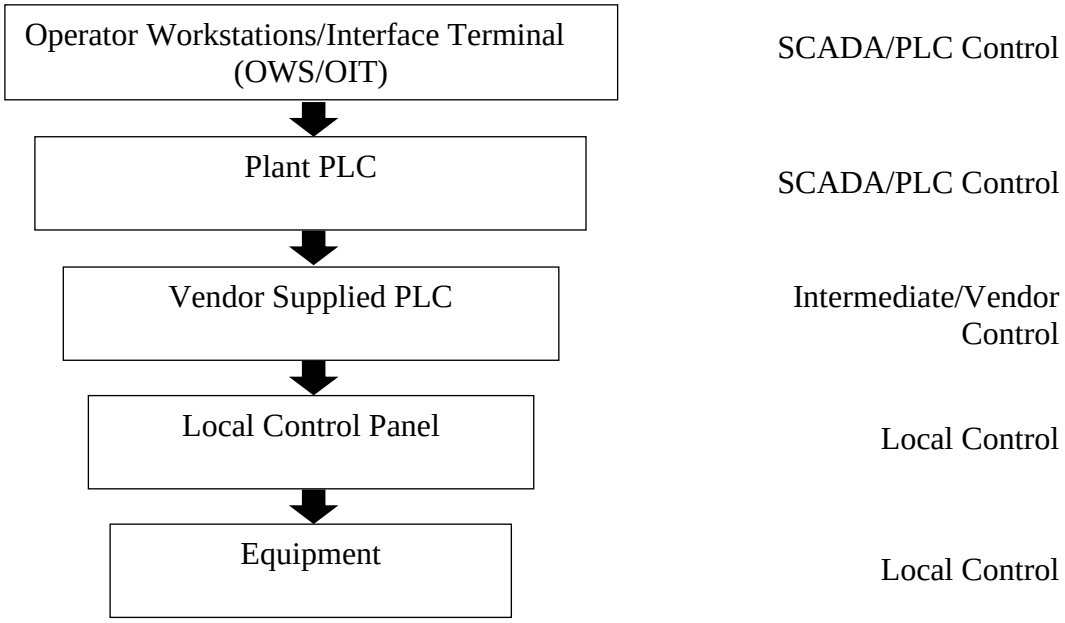


Figure 1. Control System Hierarchy

B. Loop Numbering

1. The control descriptions are separated into areas and sorted by loop number. The loop index has three columns associated with it; Process Area, Loop Number, and Drawing (s). The following is a list of areas and the loop numbers associated with each area.

Process Area	Area Number	Loop Number	Drawing (s)
Reston Pump Station	01	0100	I-4

2. The loop numbering for each system would be the above numbers, with -99 added onto the end of the area designation. For example, loop numbers associated with the Plant Process Pumping System would be 0100 to 0199.

3.2 GENERAL CONTROLS AND MONITORING

A. Overview

1. The hardware and/or software functions noted by this paragraph reference are to be implemented in the PLC control system.
2. Setpoints, as defined by this section, refer to numerical values adjustable from the HMI.
3. The PLC is responsible for resetting command bits sent from the HMI to the PLC. If the commanded state cannot be achieved for any reason, the PLC resets the bit to allow the operator to set the command bit again. For example, when pressing the AUTO button on the HMI, the PLC resets the AUTO command from the HMI after the device is in the AUTO Mode. If the AUTO Mode is not available for any reason, the PLC resets the bit, so the AUTO button can be selected at the HMI once AUTO control is available.

B. Interlocks

1. Hardwired interlocks will interlock the controls locally, at the vendor PLC, and at the plant PLC. If the interlock occurs, the shutdown will cause the equipment to be inoperable at all levels of control.
2. Software interlocks are represented in a particular layer of the operation description and interlock the controls in that layer and the layers above it. However, the interlock does not interlock the commands in the layer before it. For example, a software interlock implemented at the SCADA/PLC level will not stop equipment from being controlled locally.
3. Interlocks that shutdown (stop a piece of equipment and prevent it from being restarted or moved) are displayed on the faceplate pop-up graphic for that piece of equipment.

C. Motors

1. Provide monitoring and control of the signals shown on the P&IDs.
2. Hardwired and software interlocks are defined in individual loop descriptions.
3. Motors can be started manually by the operator at the HMI, or automatically by the control strategy.
4. Automatic control strategies are defined in individual loop descriptions.
5. The SCADA system stops a motor or drive, if it does not receive the AUTO or REMOTE status or one of its software interlocks trips. If the drive or motor is in

HAND or LOCAL, it will continue to run but the SCADA start/stop output will be open.

6. If a motor stops for any reason, it cannot be restarted automatically once the problem with the motor has been resolved. A manual reset from the OWS or OIT is required to resume operation.
7. Motors that have a HAND-OFF-AUTO (HOA) selector, indicate to the operator that the pump is being run in the HAND position. A motor is being run in HAND when the AUTO position is not true and the run confirm status is true. If not in AUTO, the SCADA PLC output contact will open and stop (shutdown) the pump.

D. Valves

1. Provide monitoring and control of the signals shown on the P&IDs.
2. Hardwired and software interlocks are defined in individual loop descriptions.
3. Valves with only full travel capability can be opened or closed manually by the operator at the HMI, or automatically by the control strategy.
4. Modulating valves with position feedback can be positioned between 0% and 100% open manually by the operator at the HMI, or automatically by the control strategy.
5. Automatic control strategies are defined in individual loop descriptions with their corresponding process variable used for control.

E. Analog Instruments

1. Analog instruments refer to indicating devices capable of providing a continuous output relative to time.
2. Provide monitoring of the analog signals shown on the P&IDs.
3. Analog signals may be a continuous voltage (-10V to 10V, 0V to 5V, 0V to 10V) or current (0 mA to 20mA, 4mA to 20mA) as determined by the output of the field instrument. The output range corresponds to the minimum and maximum full-scale measurement.
4. The PLC will linearly scale the output range (voltage or current) to the equivalent values in engineering units.
5. Provide cutoff deadbands for when the analog signal is approaching the minimum or maximum full-scale measurement.

    a. An analog signal measuring less than or equal to 2% of full-scale will be forced to zero after an adjustable time delay.
    b. An analog signal measuring greater than 100% of full-scale will be clamped at 100%.

6. Provide a CALIBRATION mode with an adjustable time setpoint (in hours).

    a. When entering CALIBRATION mode, the last good value is held prior to CALIBRATION mode being activated. The value is held until the calibration time setpoint expires.
    b. The Operator may enter a calibration value, which will be the value held until the calibration time setpoint expires.
    c. When active, clearly indicate the instrument is in CALIBRATION mode on any local OITs and in the HMI system.

F. Discrete Instruments

1. Discrete instruments refer to indicating devices with any number of non-continuous defined states (e.g., ON/OFF, 0 or 1)

2. Provide monitoring of the discrete signals shown on the P&IDs.

    a. When a contact or status from the instrument is true, the PLC will receive power to its input channel. The PLC registers this as a binary bit of 1.
    b. When a contact or status from the instrument is false, the PLC will receive no power (open circuit) to its input channel. The PLC registers this as a binary bit of 0.

G. PLC Hardware

1. Monitor status and communication faults at the HMI.

    a. Implement watchdog timers to monitor CPU and I/O module health, and execution time for PLC routines.
    b. Generate an alarm at the HMI if any watchdog timer expires.

2. Program the system time for all PLCs to synchronize with a Network Time Protocol (NTP) server once every 24 hours.

H. Input Validation

1. Provide input validation for setpoints used in process control (e.g., chemical dosage setpoints, pump flow setpoints).
2. The PLC will verify that the HMI setpoint is within an acceptable predefined range.
3. Out of range values will be rejected by the PLC and the current value will be retained.

3.3 HISTORICAL DATA COLLECTION

A. Provide historical data collection for all analog inputs, process control setpoints, flow totals, equipment runtimes, and discrete equipment statuses (ON/OFF), unless otherwise stated in the individual loop descriptions. Historical data collection is as follows:

Collection Options	
Collection Type:	Polled
Collection Interval:	1 minute
Collection Offset:	0 seconds
Time Resolution:	Milliseconds
Compression:	Enabled
Collector Deadband:	0.5 Percent Range
Collector Compression Timeout:	15 minutes

3.4 ACCUMULATORS AND TOTALIZERS

A. Accumulators

1. Display accumulated run time for all equipment with a RUNNING status. Each run time accumulation is resettable from the HMI with a reset push button.
2. The PLC will update the flow totals at 12:00 a.m. local time.

Runtime	Display Format
Current Day:	XX.XX Hrs.
Yesterday:	XX.XX Hrs.
Current Month:	XXX.X Hrs.
Previous Month:	XXX.X Hrs.
Accumulated Total:	XXXXXX Hrs.

B. Flow Totalizers

1. Totalize all flow indications.

   a. If the flowmeter provided has a configurable pulse output for totalized flow, perform flow totalization using the pulse output. The PLC calculates totalized flow by multiplying the number of pulses by the volume per pulse.
   b. If the flowmeter provided does not have a configurable pulse output for totalized flow, perform flow totalization using the analog 4-20mA signal.

      1) Do not totalize if the analog signal is outside the 4-20 mA range.
      2) Do not totalize if the value of the flow input is less than 2% of the full range of the input.
      3) Do not totalize if a discrete status exists that can be used to determine if flow is present (for example, no flow can be present unless a pump is running).

2. Each flow totalization is resettable from the HMI/OIT with a reset push button.
3. Display totalized flow in million gallons (MG), thousands of gallons (kGal), or Gallons (Gal) in accordance with the following:

Totalizer	MG Format	kGal Format	Gal Format
Current Day:	X.XXX	XXX.XX	XXXX.X
Yesterday:	X.XXX	XXX.XX	XXXX.X
Current Month:	XXX.X	XXX.X	XXXX
Previous Month:	XXX.X	XXX.X	XXXX
Accumulated Total:	XXXX	XXXX	XXXX

4. Use appropriate flow totalizer units for the total volume anticipated for the time period. Unless requested by the Owner, water process flows are totalized in million gallons (MG) and chemical flows are totalized in gallons (Gal). Auxiliary flow (e.g., backwash) units are determined based on the total flow for the day.
5. Chemical systems which do not have flowmeters will calculate usage based on the chemical tank volume. The PLC will calculate tank volume based on the measured level and the vessel geometry or the measured weight and the specific weight of the chemical.
6. The PLC will update the flow totals at 12:00 a.m. local time.

3.5 ALARMING AND EQUIPMENT FAILURES

A. Analog Alarms

1. Provide analog alarming capability for all analog signals monitored by the PLC.

2. Supervisor level users can set a common time setpoint (initially set to 5 seconds) that is used to generate alarms. The following alarms (setpoints to be Supervisor adjustable) are generated based on the analog feedback value. Each alarm includes the ability for individual enabling and disabling.

    a. High-High
    b. High
    c. Low
    d. Low-Low
    e. Loss of Signal

3. LOSS OF SIGNAL alarm is generated when an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card. The following SCADA programming occurs:

    a. If the analog signal is used in a control loop or ratio control loop, that loop is placed into MANUAL.
    b. If the analog signal is used in a calculation, that calculation uses the last good analog signal. If the calculation is used in a control loop, that loop is placed into MANUAL.

4. SETPOINT REJECTED alarm is generated at the HMI when an analog setpoint is out of range and rejected by the PLC.

B. Discrete Alarms

1. Program all discrete alarm signals wired to the PLC (float switches, pressure switches, overload alarms) to alarm after an HMI adjustable time delay expires.
2. The maximum alarm delay for Safety related alarms (e.g., E-stop) is 500ms. Set each alarm timer during startup.

C. Motor Failure Alarms

1. Supervisor level users can set a common elapsed time setpoint for each scenario below:

    a. Motors being remotely controlled generate a FAIL-TO-START alarm when the PLC sends the START command to the motor and it does not receive a RUNNING status from the motor after a supervisor adjustable time setpoint. When a FAIL-TO-START alarm is generated, the START output command from the PLC is deenergized and the motor is prevented from starting until a reset is issued from the HMI.
    b. Motors being remotely controlled generate a FAIL-TO-STOP alarm when the PLC sends the STOP command to the motor and it continues to run after a supervisor adjustable time setpoint.
    c. Motors with adjustable speed control generate a SPEED DEVIATION alarm when the motor is running and the PLC sends a speed setpoint to the motor and it does not reach the correct speed (within a deadband, initially set to 10%) within a supervisor adjustable time setpoint. The motor remains running if the SPEED DEVIATION alarm is activated.

D. Valve Failures

1. Supervisor level users can set a common time setpoint that is used to generate the following alarms. When a valve position alarm is active, the PLC output is

maintained unless explicitly stated in the individual loop descriptions (e.g., a fail to open alarm does not trigger the PLC to close the valve).

a. All discrete valves (OPEN-CLOSE) being remotely controlled generate a FAIL-TO-OPEN alarm when the PLC sends the OPEN command to the valve and it does not reach the OPENED limit within a supervisor adjustable time setpoint.
b. All discrete valves (OPEN-CLOSE) being remotely controlled generate a FAIL-TO-CLOSE alarm when the PLC sends the CLOSE command to the valve and it does not reach the CLOSED limit within a supervisor adjustable time setpoint.
c. All modulating valves (POSITIONING) being remotely controlled generate a FAIL-TO-POSITION alarm when the valve feedback does not match the PLC commanded position within a supervisor adjustable time setpoint.

3.6 INDIVIDUAL CONTROL DESCRIPTIONS AND CONTROL SEQUENCES

LOOP No.	**LOOP DESCRIPTION**	**PAGE No.**
LOOP 111	PUMP NO. 1	8
LOOP 112	PUMP NO. 2	9
LOOP 113	PUMP NO. 3	9

LOOP 111 PUMP NO. 1

A. General

1. Pump with variable speed drive.

B. Hardwired Interlocks

1. The pump cannot run if the following alarms are detected:

a. E-Stop
b. High Motor Temperature

C. Control

1. There is a LOCAL/OFF/REMOTE selector switch at the VFD:

a. In LOCAL, the operator starts and stops the pump and adjusts the pump speed at the pump VFD.

b. In REMOTE, the operator starts and stops the pump and adjust the pump speed from the SCADA system.

c. In OFF, the pump does not run.

D. Alarms/Monitoring

1. Provide the motor control, monitoring, runtime accumulation, and failure alarming, as described in “General Controls and Monitoring”, “Accumulators and Totalizers,” and “Alarming and Equipment Failures” Articles of this section.

E. Historical Data Collection

1. Provide historical data collection as described in “Historical Data Collection” Article of this section.

LOOP 112 PUMP NO. 2

A. General

1. Pump with reverse voltage soft starter drive.

B. Hardwired Interlocks

1. The pump cannot run if the following alarms are detected:

a. E-Stop
b. High Motor Temperature

C. Control

1. There is a LOCAL/OFF/REMOTE selector switch at the RVSS:

a. In LOCAL, the operator starts and stops the pump at the pump RVSS.

b. In REMOTE, the operator starts and stops the pump from the SCADA system.

c. In OFF, the pump does not run.

2. Pump flow is throttled by the position of the pump discharge control valve (BV-122). Valve position is entered from the SCADA System.

D. Alarms/Monitoring

1. Provide the motor control, monitoring, runtime accumulation, and failure alarming, as described in “General Controls and Monitoring”, “Accumulators and Totalizers,” and “Alarming and Equipment Failures” Articles of this section.

E. Historical Data Collection

1. Provide historical data collection as described in “Historical Data Collection” Article of this section.

LOOP 113 PUMP NO. 3

A. General

1. Functionally identical to Loop 111

LOOP 140 SWITCHBOARD SWBD-001

A. General

1. Monitoring of Switchboard.

B. Alarms/Monitoring

1. Provide the motor control, monitoring, runtime accumulation, and failure alarming, as described in “General Controls and Monitoring”, “Accumulators and Totalizers,” and “Alarming and Equipment Failures” Articles of this section. The following will be monitored:

a. Loss of Utility Power

C. Historical Data Collection

1. Provide historical data collection as described in “Historical Data Collection” Article of this section.

LOOP 160 GENERATOR

A. General

1. Monitoring of generator.

B. Alarms/Monitoring

1. Provide the motor control, monitoring, runtime accumulation, and failure alarming, as described in “General Controls and Monitoring”, “Accumulators and Totalizers,” and “Alarming and Equipment Failures” Articles of this section. The following will be monitored:

a. Generator Fail

b. Generator Running

c. Low Fuel Level

C. Historical Data Collection

1. Provide historical data collection as described in “Historical Data Collection” Article of this section.

END OF SECTION 13614

SECTION 15042 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide grounding rings or straps on motors with variable frequency controller.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15042

This page left intentionally blank.

SECTION 15061 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Fastener systems.
3. Equipment supports.
4. Delegated Design.

B. Related Requirements:

1. Section 05502 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 15064 "Vibration Controls for HVAC" for vibration isolation devices.
3. Section 15712 "Metal Ducts" for duct hangers and supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 DELEGATED DESIGN SUBMITTALS

A. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Equipment supports.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

C. Qualification Data: For professional engineer and testing agency.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01400 "Quality Requirements," to design exterior equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector.
b. Hilti, Inc.
c. MKT Fastening, LLC.

2. Indoor Applications: Stainless-steel.
3. Outdoor Applications: Stainless steel.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural stainless-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B 221.

B. Stainless Steel: ASTM A 240/A 240M.

C. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 07841 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use Type 316 Stainless-steel hangers and supports for the Pump Room and exterior.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
2. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
3. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.

4. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
5. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

J. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

K. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 15061

SECTION 15064 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Elastomeric hangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 DELEGATED-DESIGN SUBMITTAL

A. For each vibration isolation device:

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. Isolation Technology, Inc.
    c. Mason Industries, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. Mason Industries, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03303 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03303 "Cast-in-Place Concrete."

END OF SECTION 15064

SECTION 15065 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Red.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Refrigerant and Condensate Piping: Black letters on a safety-white background.

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 15065

This page left intentionally blank.

SECTION 15091 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, exposed supply, return, and outdoor air.

1.3 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 15061 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.4 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.9 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 15061 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ . Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller.

2.3 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Knauf Insulation.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Vimasco Corporation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Knauf Insulation.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Gemco.
        2) Midwest Fasteners, Inc.

    b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

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

a. C & F Wire Products.
b. Johns Manville; a Berkshire Hathaway company.
c. RPR Products, Inc.

2.9 CORNER ANGLES

A. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over compress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, exposed supply, return, and outdoor air.

B. Items Not Insulated:

1. Factory-insulated plenums and casings.
2. Flexible connectors.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular, supply-air and return-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

END OF SECTION 15091

This page left intentionally blank.

SECTION 15105 – LOW-VOLTAGE MOTOR REQUIREMENTS FOR PROCESS 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 SUMMARY

A. Section Includes:

1. Three-phase motors for application on process equipment provided under other Sections.
2. Motors furnished loose to Project.
3. Motor Manufacturer or supplier will have unit responsibility for supplying the motor, coordinating the required adapter plate for new motor mounting to the existing pump and motor base frame, any modifications to the existing pump and motor base frame, and the required vibration dynamic field study and analysis.

B. The manufacturer of the driven equipment shall provide the associated motor.

C. Related Requirements:

1. Section 16056, “Grounding and Bonding for Electrical Systems”.
2. Section 16070, “Identification for Electrical Systems”.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

B. VFC: Variable-frequency motor controller. See VFD.

C. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 SUBMITTALS

A. Product Data: For each type and rating of motor indicated.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include nameplate data, compliance with specified standards, electrical ratings and characteristics, physical dimensions, frame size, weights, mechanical performance data, support points and the following:

a. Descriptive bulletins, including full description of insulation system.
b. Bearing design data.

c. Efficiency at ½, ¾ and full load.
d. Power factor at ½, ¾ and full load.
e. Conduit entry points and sizes.
f. Special features and accessories (i.e. space heaters, temperature detectors, etc.).
g. Power factor correction capacitor rating and type (when required).

3. Prior to Manufacture: Submit dynamic vibration analysis and existing conditions field testing report describing the analysis process, assumptions utilized in the analysis, and analysis conclusions as described in Paragraph 2.9. Report to identify the specified limitations will be met with the new motors installed on VFD power per the specification. For the dynamic vibration analysis described, minimum and maximum operating speeds will be in accordance with conditions of operation specified in Section 2.3 for each pump unit with a new motor.
4. Motor adapter plate drawing indicating size and location of bolt holes for anchorage plus details of anchorage of equipment to existing pump and motor base frame including bolt type, size, materials, welds, and minimum edge distance.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Qualifications Statements:

1. Submit qualifications for manufacturer and testing agency.

1.5 QUALITY ASSURANCE

A. Electric motors driving identical equipment shall be identical. To assure unity of responsibility, the motors and motor adapter plate shall be furnished and coordinated by the Manufacturer or Supplier. The motors shall be coordinated with the provided VFDs and/or RVSSs.

B. Motors shall be listed under UL recognized component file as applicable.

C. Motor manufacturer to maintain a documented ISO 9001 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.

D. When electrically driven equipment differs from that indicated, adjust the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed.

E. Testing Agency Qualifications: Member company of NETA.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship motor fully assembled, capable of being lifted in one piece. Comply with Section 01600, "Materials and Equipment" for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on site in manufacturer's original packaging and inspect for damage.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Energize motors furnished with space heaters to prevent condensation throughout the storage and construction period. Perform periodic motor insulation resistance tests per manufacturer's storage recommendations.
3. For extended outdoor storage, remove motors from equipment and store separately.
4. Maintain bearings during storage and construction period, and periodically rotate the motor shaft per manufacturer's storage recommendations.
5. Lubricate per manufacturer's recommendations and inspect purged grease for water, rust, or other contaminants.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of motors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion for inverter duty motors.
2. Warranty Period: Five years from date of Substantial Completion for constant speed severe-duty motors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Nidec (US Motors)
2. ABB (Baldor-Reliance)
3. TECO-Westinghouse
4. Toshiba
5. WEG
6. General Electric
7. Or equal

2.2 SYSTEM DESCRIPTION

A. Three new motors will be installed and connected to the three existing horizontal split case pumps. Adapter plates will be furnished with each new motor to ensure shaft alignment with each existing pump.

1. Two of the new motors will be operated on VFDs.
2. One of the new motors will be operated on a RVSS.

B. For control descriptions and control sequences, refer to Section 13614 Process Control Descriptions. Coordinate for proper operation and compatibility.

C. Motor Units:

1. Supply by one Manufacturer.
2. Complete system including existing pumps, motors, motor adapter plate, and appurtenances such as, but not limited to, existing pump and motor base frame, couplings, guards, and gauges. The system shall be coordinated with the VFDs and/or RVSSs.
3. Provide ample room for inspection, repairs and adjustments.

D. Design and build motors for 24-hour continuous service at any and all points within the required range of operation, without overheating, excessive vibration or strain.

2.3 SPECIFIC MOTOR REQUIREMENTS AND EXISTING PUMP INFORMATION

A. Motor Orientation: Horizontal.

B. Motor Horsepower: 200.

C. Enclosure: Open Drip Proof (ODP).

D. Bearings: Anti-Friction, grease lubricated type.

E. Motor Voltage: 460 V.

F. Motor Frequency: 60 Hz.

G. Number of Phases: 3.

H. Maximum Motor Speed (Full Load Speed): 1,790 rpm.

I. Minimum Speed (As Percentage of Full Load Speed): 50%.

J. Motor Accessories:

1. Space heater.
2. Winding Temperature Protection: Bi-metallic winding temperature switch.

K. Pump Motors: Suitable for driving the pumps continuously over the entire pumping range. Furnished by the Manufacturer. Constructed and guaranteed to withstand pump reverse runaway speed equal to 150 percent of synchronous speed or the runaway speed that would occur at an applied head equal to the head at the best efficiency point, whichever is higher.

L. Lubrication Fittings: Bring fittings to outside of equipment so they are readily accessible without removing covers, plates, housings, or guards, and without creating falling hazards.

1. Type: Buttonhead.
2. Mount together wherever possible.
3. Pressure Grease-Lubricated Fittings: "Zerk Hydraulic" or "Alemite" type.

4. Bearing Housings of Grease-Lubricated Bearings: Automatically exhausted to atmosphere preventing excessive greasing.

M. Motors shall be mounted to the Baseplate with Heavy Hex Grade 8 bolts, nuts and washers torqued to the Manufacturer's recommended value.

N. Existing Pump Serial Numbers:

1. Pump No. 1: Aurora Model Number 4 11 BF, SN 75-5749-2.
2. Pump No. 2: Aurora Model Number 4 11 BF, SN 75-5749-3.
3. Pump No. 3: Aurora Model Number 4 11 BF, SN 75-5749-1.

O. Existing Pumps Total Head: 185 feet.

P. Existing Pumps Rated Flow: 3,000 gpm.

2.4 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with the latest revision of the following as applicable:

1. NEMA MG 1, "Motors and Generators".

C. Unless otherwise noted, all motors ½ through 100 horsepower shall be rated 230/460 Volt, three-phase, 60 Hertz A.C.; motors 125 horsepower and above shall be rated 460 Volt, three-phase, 60 Hertz; and motors below ½ horsepower shall be rated 115/230 Volt, single phase, 60 Hertz A.C.

D. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

E. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

F. Horsepower rating: Size for operation within the full load nameplate rating without applying the service factor, throughout the full range of mechanical or hydraulic operating condition.

G. Specific motor application data such as Hp, rpm, enclosure type, accessories, etc., are specified under the detailed driven mechanical equipment specification.

H. Nameplates: Engrave or emboss on 316 stainless steel fastened to the motor frame with stainless steel screws or drive pins with information per NEMA MG 1.

I. Space heater: Include 120-volt space heater for moisture control on all motors rated 50 horsepower and larger.

J. Service Factor: 1.15 service factor on sine wave power and 1.0 service factor on VFD power in a 40 degrees C ambient, unless otherwise noted.

K. Motors and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

L. Enclosures: Conform to one of the NEMA standard enclosure designs as specified under the detailed driven mechanical equipment specification. If no enclosure type is specified, provide TEFC (Totally Enclosed Fan Cooled) enclosures.

M. Motors connected to VFCs: Inverter duty rated and comply with NEMA MG 1, Part 31. First or second torsional critical speed shall be outside the operating speed range for all VFC controlled motors.

N. Three-phase motors:

1. Description: NEMA MG 1, Design B, medium induction motor.

2. Efficiency: Meet or exceed requirements for NEMA MG 1, Part 12 for Premium Efficient motors 1 HP and larger.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Rotor: Random-wound, squirrel cage.
6. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code C.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

7. Accessories: Where specified herein, or under process mechanical specification.

2.5 THREE PHASE MOTOR CONSTRUCTION

A. Enclosure and Frame:

1. NEMA enclosure type as specified above.
2. NEMA frame for the associated horsepower.
3. Motor frames: Cast iron or welded heavy plate steel construction, stiff enough to withstand the rotating forces and torques generated and designed to limit or avoid any undesirable harmonic resonances.
4. Provide a threaded, forged steel, shouldered eyebolt blind tapped into the motor frame for lifting on all frames 254T and larger.
5. Condensate drain openings: Locate drain holes at the low points in the end brackets to allow removal of accumulated moisture from enclosures. Provide corrosion resistant, breather drain plugs for severe-duty motors.
6. Hardware: Hex head, SAE Grade 5 or better, plated for corrosion protection.
7. Nameplates: Engraved or embossed stainless steel plates fastened to the motor frame with stainless steel screws or drive pins. Clearly indicate all items of information listed in the applicable part of NEMA MG 1.

8. Main terminal box: Fabricated steel or cast iron, sized per the NEC for number and size of conduit connections and conductor bending and terminations as indicated on the Drawings. Split box top to bottom with capability to rotate entry point to any quadrant. Provide gaskets between the box and motor frame and between box and its cover. Include ground lug for equipment grounding conductor termination.
9. Bearing housings: Provide machined surfaces for attaching a magnet mounted accelerometer to monitor the motor vibration in the vertical, horizontal, and axial directions at each bearing housing.
10. Frame grounding: provide motor frame grounding pad or threaded stud where supplemental grounding to frame is indicated on the drawings.

B. Windings:

1. Copper
2. Insulation rating: Class F.
3. Temperature rise: Class B at 1.0 SF, Class F at 1.15 SF.
4. Insulation: Non-hygroscopic, epoxy encapsulated windings for enclosure types WP I and WP II. Provide upgraded insulation by additional dips and bakes to increase moisture resistance for totally enclosed designs. Provide vacuum pressure impregnated (VPI) epoxy insulation for moisture resistance for outdoor motors.
5. Provide chemical and humidity resistance insulation system when IEEE 841 motors are specified.
6. Provide winding surge withstand capability per NEMA 1, Part 31 for VFC driven motors.
7. Provide specified temperature sensing devices for VFC driven equipment. If not specified, provide a winding temperature detector per the accessories paragraph.

C. Motor leads: Non-wicking type, minimum Class F temperature rating and permanently numbered for identification.

D. Stator: Built up core using high grade, low loss silicon steel laminations keyed or dovetailed to the stator frame and securely held in place at each end.

E. Rotor:

1. Forged or rolled steel shaft, machined, smooth finished, with sufficient strength for operation including 25 percent overspeed condition.
2. Shaft end coordinated with driven equipment coupling.
3. Entire assembly coated with protective coating.
4. Inpro seals on both ends of the shaft to prevent grease leakage and entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest. Severe duty motors to have improved sealing per IEEE 841.
5. Vertical Motor Shafts:

    a. Provide hollow shaft and P flange mounting to allow driven shaft to extend through provide for vertical pump applications.
    b. Coupling for connecting the motor shaft to the driven shaft is located in the top of the motor.
    c. Where solid shaft is provided couple the driven shaft below the P flange face.

6. Rotor Core:

a. Solid, built-up stack of fully processed and coated, high-grade, low-loss silicon steel laminations.
b. Die cast aluminum or fabricated copper bars or their respective alloys.
c. Rotors on frames 213T and above to be keyed to shaft and rotating assembly dynamically balanced.

7. Rotor Assembly:

a. Coated with corrosion resistant epoxy insulating varnish or other protective coating, thermally stable, statically and dynamically balanced.
b. Balance weights securely attached to the rotor resistance ring by welding or similar permanent method.

F. Horizontal Bearings: roller type, grease lubricated.

1. Bearings: Anti-friction open or single-shield, vacuum-degassed steel ball or roller bearings, electric motor quality, designed for 45 degrees C maximum temperature rise. Metric size bearings are not acceptable.
2. Life: L 10 life of 100,000 hours for direct coupled applications and 26,000 hours for belted applications based. IEEE 841 motors, L 10 life increased to 150,000 and 50,000 hours respectively.
3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
4. Shaft currents: Provide mitigation per Section 2.6.
5. Comply with ABMA requirements.

G. Vertical Bearings: per manufacturer, thrust type.

1. Bearings: Manufacturer's standard design, constructed with thrust bearings on top to allow inspection and/or replacement without requiring complete disassembly of motor, of type and size to satisfy thrust loading requirements.
2. Life: Rated for an in-service L 10 life of 100,000 hours, designed to support the weight of the rotor plus, if required, the weight of the rotating driven equipment parts and the hydraulic thrust created by the driven equipment, with a 40 degrees C maximum temperature rise. Metric bearings are not acceptable.
3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
4. Shaft currents: Provide mitigation per Section 2.6.
5. Comply with ABMA requirements.

2.6 THREE PHASE MOTOR ACCESSORIES

A. Space heaters: Silicone rubber strip type, accessible for inspection, rated 120 Volt, single phase, designed to prevent condensation inside the enclosure when the motor is idle, with leads brought out to a separate terminal box. Emboss the heater wattage and voltage on the motor nameplate.

B. Winding temperature switch: Three embedded bi-metallic temperature thermostat switches with normally open or normally closed and leads terminating in the main conduit box.

C. Motor shaft currents: insulate the ODE bearing and provide a shaft grounding strap. Insulate bearing probes to prevent shorting out bearing insulation.

D. Shaft grounding rings: maintenance free, circumferential micro fiber type, AEGIS™ SGR by electro Static Technology or equal to discharge shaft currents to ground.

E. Anti-Backspin Device: Provide shaft mounted, mechanical non-reverse ratchet rated at 100 percent of motor full load torque for immediate protection against reversing due to phase reversals or from backspin at shutdown.

F. Encoder for vector drive motors: Provide encoder on opposite drive end to sense rotor speed and provide closed loop feedback (quadrature signal with line driver output) to a control device. Provide sufficient length of encoder cable to connect encoder to variable frequency controller.

2.7 Motor to Pump Coupling:

A. Pump drive shaft shall be directly connected to the motor by means of a TB Wood's Sureflex flexible coupling, suitably sized to transmit the required driving torque and axial unbalanced thrust.

B. Coupling Sleeve Material: EPDM

2.8 Motor Adapter Plate:

1. Material: Carbon steel – Epoxy Coated.
2. Size: Manufacturer to size adapter plate to accommodate new motor to be installed on existing pump and motor base frame and coupled to existing pump.
3. Adapter plate to ensure motor shaft is aligned with existing pump shaft within a tolerance as specified by the motor manufacturer.
4. Final design of adapter plate to be coordinated with dynamic vibration analysis.

2.9 EXISTING FIELD CONDITION TESTING AND DYNAMIC VIBRATION ANALYSIS

A. Performed by:

1. Mechanical Solutions Inc. (MSI) of Whippany, NJ,
2. Engineering Dynamics Inc. (EDI) of San Antonio, TX.
3. Approved equal.

B. Existing Field Condition Testing:

1. Specialized vibration testing to be completed on all three pumps and motors. The testing will include baseline vibration data and characterization of the existing pump system to evaluate the pump and baseplate for the new motors and VFDs. The specialized vibration testing will include the following:

    a. Experimental Modal Analysis:

1) Perform an on-site experimental modal analysis (EMA) test (i.e., "impact" test) on accessible locations of the pump (up to a total of 14 test data points), motor, and pump shaft to determine the structural and lateral natural frequencies of the pump, motor, and pump shaft. This test first will be performed in the direction parallel to the discharge, and then in the direction perpendicular to the discharge. The test firm will perform these modal tests when the pump is not operating and is at rest conditions. The EMA testing for the pumps will occur when the pump is filled with water. FRF plots will be produced to show the structural natural frequency of the pump, motor, and pump shaft so the testing firm can more carefully evaluate if further structural or lateral dynamic analysis is needed on the pump based on the new operating speed range.

b. Torsional natural frequency analysis of the existing pump motor system:

1) A strain gauge shall be installed on a single pump to provide baseline torsional natural frequencies of the existing pump/motor rotor. This data will be used to calibrate the torsional analysis of the new motor.

c. Continuous monitoring of pump/motor vibration:

1) The testing firm will temporarily mount triaxial accelerometers on the pump and motor bearing to measure the vibration. This will allow for an understanding of any current issues with the equipment and provide a baseline vibration. Vibration values will be compared to industry standards (ANSI/HI 9.6.4 for the pumps and ISO 10816-3 for the motors). FFTs will be reviewed for any natural frequencies.

d. Structural Assessment Testing:

1) The VibVue® Motion Magnified Video system (or equivalent) will be used to inspect the overall installation of the pumping system and identify any potential issues that need to be fixed prior to changing the motor. Potential issues could include soft foot, loose connections/piping supports, etc.

e. A report in will be issued which includes the following:

1) A summary of tests performed.
2) Results of the test.
3) Recommendations, if any, for improvements to the system prior to installation of the new motors.

C. Dynamic Vibration Analysis:

1. The extent of the dynamic vibration analysis will depend upon the results of the Existing Field Condition Testing of the pumps specified in 2.9.B. For the pump structural and lateral analysis, if the Existing Field Condition Testing results show that the natural frequency has adequate separation margins from the new operating speed range, these analyses may be omitted from dynamic vibration analysis. As a minimum, the motor structural dynamic and the torsional analysis will be included with the new motor and coupling.

2. The dynamic vibration analysis is to be initially calibrated to the existing equipment and the results of the Existing Field Condition Testing.
3. Provide lateral rotordynamic vibration analysis (if required based on Existing Field Condition Testing) of the pump rotating system, including pump and installed bearing stiffness.

    a. Identify and predict that the first lateral critical speed shall have a separation margin of at least 20 percent above the maximum pump speed or 20 percent below the minimum pump speed.
    b. imum pump speed.
    c. If a design modification (i.e., such as changing the shaft diameter or different coupling arrangement) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to demonstrate that deflections at the bearings or at the impeller wear rings, if applicable, will not exceed 35% of the available clearances.

4. Provide torsional rotordynamic vibration analysis of the complete rotating system (pump, motor, shafting, and coupling).

    a. Identify and predict that no torsional natural frequencies occur within a separation margin extending from 20 percent below to 20 percent above the specified pump operating speed range.
    b. Additionally, no natural frequencies shall be +/- 10% of 2x times running speed, line frequency, 2x line frequency, vane pass frequency, and VFD control frequencies (if applicable) within the specified multiple of the pump operating speed range.
    c. If a design modification (i.e., such as a shaft diameter change or different coupling arrangement) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to show that infinite life will be achieved with a safety factor of at least two.
    d. ith a safety factor of at least two.

5. Provide structural dynamic analysis of the pump (if required based on Existing Field Condition Testing), new motor, motor adapter plate, and baseplate.

    a. Identify and predict that no first or seconding bending mode frequency exists within a separation margin of 20 percent below to 20 percent above the specified pump operating speed range.

6. Submit Campbell diagrams documenting lateral rotordynamics, and torsional rotordynamic analysis results and graphically demonstrating the separation margins specified above.
7. the separation margins specified above.
8. Maximum Vibration Velocity: Per ANSI/HI 9.6.4 as measured in the field for all specified operating conditions.
9. Maximum Vibration Displacement: Field vibration displacement peak-to-peak shall conform to the requirements of ANSI/HI 9.6.4 for specified operating conditions at or below 600 rpm. This only applies if full or reduced speeds will be below 600 rpm.

2.10 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Factory Testing: Prior to shipment perform manufacturer’s standard tests in accordance with NEMA MG 1 and IEEE 112.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of motor and prior to unloading, inspect equipment for damage.

B. Comply with DELIVERY, STORAGE, AND HANDLING article within this specification.

3.2 INSTALLATION

A. Prepare rigid foundation or mounting surface to minimize vibration and maintain alignment between motor and load shaft.

B. Install the motors per manufacturer's installation instructions.

C. Anchor motor base to load bearing surface with grade 5 steel bolts or better.

D. Align the motor shaft with driven equipment according to manufacturer’s written instructions. Adjust axial position of motor frame with respect to load shaft.

E. Accurately adjust flexible couplings for direct drive according to machine manufacturer’s guidelines. Check alignment to minimize vibrations. Coupling spacing shall be according to coupling manufacturer guidelines.

F. Install motor branch circuit conduits and conductors in accordance with NEC and local code requirements. Connect motors to rigid conduit system by a short section of liquid-tight flexible conduit to isolate the conduit system from motor vibration. Where motors are installed outdoors, bring conduit into bottom of motor terminal box to avoid standing water at connection point.

G. Terminate the motor leads as shown on the connection diagrams using products intended for vibration applications.

H. Ground equipment according to Section 26056, “Grounding and Bonding for Electrical Systems.”

I. Tighten electrical connections and terminals according to manufacturers' published torque values.

J. Install conduit and wiring between motor auxiliary devices and associated indicators, controllers and protective devices in accordance to installation drawings.

K. Connect devices sensitive to electromagnetic interferes such as RTD's, thermistors, thermal protector switches, vibration sensors with shielded instrumentation wiring per installation drawings.

L. Comply with NECA 1.

M. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

3.3 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553, "Identification for Electrical Systems." Identify field-installed conductors, interconnecting wiring, and components.

3.4 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until motors are ready to be energized and placed into service.

B. Lubrication and Shaft Rotation: Lubricate parts and rotate shaft periodically according to manufacturer’s written instructions until motors are ready to be energized and placed into service.

3.5 FIELD QUALITY CONTROL

A. Perform inspections and tests Inspect and test according to the Inspection and Test Procedures for Rotating Machinery state in NETA Acceptance Testing Specification paragraph 7.15.1.

B. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Motors will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies the motor and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP AND ADJUSTMENT

A. Complete installation and startup checks according to manufacturer's written instructions. Confirm motor is structurally, mechanically, and electrically ready for start-up. Checks include support system, vibration isolation, alignment, lubrication system, and cleanliness.

B. Verify correct phase rotation at motor with driven equipment uncoupled. Correction for phase rotation to be made in the motor terminal box.

C. Prepare inspection and test reports.

3.7 DEMONSTRATION / SYSTEM FUNCTION TESTS

A. Run motor for system testing as required in motor controller and driven equipment specifications.

B. Confirm correct operation of all protective and metering devices.

C. Measure voltage and motor running current and evaluate relative to load conditions and nameplate full load amperes. Corrective action is required for any current imbalance 10 percent or greater.

D. Prepare driven equipment system testing report. Include results of all tests and check made, meter readings and recordings, and summary adjustments made. Clearly identify any discrepancies and concerns.

E. Prior to any pump mechanical test, the Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor.

F. Prior to any pump mechanical test, the Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with the motor manufacturer's instructions. The Contractor shall check direction of rotation of all motors prior to any pump mechanical test and reverse connections, if necessary.

G. When full speed operation can be accomplished:

1. Retain the services of a fully qualified independent mechanical vibration testing and analysis firm:

    a. Mechanical Solutions Inc. (MSI) Whippany, NJ,
    b. Engineering Dynamics Inc. (EDI) San Antonio, TX or
    c. Pre-approved equal.

2. Perform a detailed vibration signature analysis of each unit(s) in accordance with ANSI/HI 9.6.4, including both "Bump Tests" and X-Y vibration profiles.

    a. Demonstrate compliance with the specified vibration limitations and
    b. Demonstrate there are no field installed resonant conditions due to misalignment, the foundation, or the connecting piping and its supports, when operating at any speed within the specified operating range.
    c. Test at design full speed, design minimum speed, and at a maximum of 3 Hz increments between minimum and full speed.
    d. Structural Assessment Testing:

        1) The VibVue® Motion Magnified Video system (or equivalent) will be used to inspect the overall installation of the pumping system and identify any potential issues as a result of the installation. Potential issues include soft foot, loose connections/piping supports, etc.

    e. Submit a written report including a detailed schematic drawing of the units indicating thereon where and in which direction the vibration readings were taken

and recorded showing (a) peak-to-peak displacement, in mils, (b) frequency spectrum, (c) peak velocity level, in inches per second, (d) velocity level, in inches per second RMS. Report complete analysis of findings, describing any problem encountered, include probable cause and specific recommendations for any required corrective action.

3. When pump system is furnished with vibration and temperature monitoring system, the motor lower vibration sensors may be used for acceptance testing. Provide temporary surface mounted sensors mounted in the vicinity of the installed sensors to establish the accuracy of the permanently installed system.
4. If required, take corrective action and retest units to ensure full compliance with this Section.

H. If required, take corrective action and have the units retested to ensure full compliance with the specified requirements.

END OF SECTION 15105

This page left intentionally blank.

SECTION 15372 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Adjustable blade face registers.

B. Related Requirements:

1. Section 15715 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Adjustable Blade Face Register SR:

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

    a. METALAIRE, Inc.
    b. Price Industries Limited.
    c. Titus; brand of Johnson Controls International plc, Global Products.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Vertical spaced 1-1/2 inches apart.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
7. Frame: 1-1/4 inches wide.
8. Mounting Frame: Filter.
9. Mounting: Countersunk screw.
10. Damper Type: Adjustable opposed blade.
11. Accessories:

    a. Front-blade gang operator.

B. Refer to the air distribution device schedule on the drawings for additional requirements.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15372

This page left intentionally blank.

SECTION 15712 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Delegated Design.

B. Related Sections:

1. Section 15905 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 15715 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 DELEGATED DESIGN SUBMITTALS

A. Sheet metal thicknesses.

B. Joint and seam construction and sealing.

C. Reinforcement details and spacing.

D. Materials, fabrication, assembly, and spacing of hangers and supports.

E. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Engage a qualified professional engineer, as defined in Section 01400 “Quality Requirements” to design the following:

1. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of aluminum unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. Where specified for specific applications, all joints shall be welded.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

1. Where specified for specific applications, all joints shall be welded.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

C. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Aluminum, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. Sealant shall have a VOC content of 420 g/L or less.
11. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.

4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Sealant shall have a VOC content of 420 g/L or less.
9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
1. Sealant shall have a VOC content of 420 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for aluminum ductwork: Type 316 Stainless-steel.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Aluminum Ducts: Stainless steel complying with ASTM A492.

D. Steel Cable End Connections: Stainless-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device for aluminum ductwork.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Aluminum Ducts: Aluminum or stainless steel.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

L. Elbows: Use long-radius elbows wherever they fit.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
3. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 15715 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    b. Return Ducts with a Pressure Class of 2- Inch wg or Higher: Test representative duct sections totaling no less than 50percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 15715 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 15905 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with aluminum except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply and Return Ducts:

1. Ducts Connected to Packaged units:

a. Pressure Class: Positive 2-inch wg.

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.

C. Intermediate Reinforcement:

1. Aluminum Ducts: Aluminum or stainless steel.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

END OF SECTION 15712

This page left intentionally blank.

SECTION 15715 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Flange connectors.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUAL VOLUME DAMPERS

A. Standard, Aluminum, Manual Volume Dampers:

1. Standard leakage rating, with linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
    e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

5. Blade Axles: Stainless steel.
6. Bearings:

    a. Stainless-steel sleeve.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Aluminum.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.2 CONTROL DAMPERS

A. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:

1. Hat shaped.
2. 0.05-inch- thick stainless steel.
3. Mitered and welded corners.

C. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Parallel-blade design.
3. Aluminum.
4. 0.064 inch thick single skin or 0.0747-inch- thick dual skin.
5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Oil-impregnated stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.3 DUCT SMOKE DETECTORS FOR UNCLASSIFIED AIR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Air Products and Controls.
2. System Sensor.

B. Type: UL or CSA listed, photoelectric.

C. Housing: Refer to Materials of Construction Schedule.

D. Sampling Tube Material: Galvanized steel for galvanized steel ducts. Aluminum for aluminum ducts.

E. Operating Voltage: 115 VAC, 24 VAC, or 24 VDC.

F. Relay Contacts: Alarm condition, trouble condition, and equipment shutdown.

2.4 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Aluminum.

C. Gauge and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Aluminum sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Aluminum sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
    d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.7 DUCT ACCESS PANEL ASSEMBLIES

A. Labeled according to UL 1978 by an NRTL.

B. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.

C. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.8 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

    1. Minimum Weight: 26 oz./sq. yd..
    2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
    3. Service Temperature: Minus 40 to plus 200 deg F.

E. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

    1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
    2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.

9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

I. Label access doors according to Section 15065 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. Install duct test holes where required for testing and balancing purposes.

L. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 15715

This page left intentionally blank.

SECTION 15806 - PACKAGED TERMINAL AIR-CONDITIONERS, OUTDOOR, WALL-MOUNTED UNITS

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 packaged, terminal, outdoor, wall-mounted air conditioners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For packaged, terminal air conditioners.

1. Include plans, elevations, sections, details for wall penetrations, and attachments to other work.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For packaged, terminal air conditioners, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged, terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bard Manufacturing Company.
2. Specific Systems.

2.2 MANUFACTURED UNITS

A. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis and circuit breaker.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE Thermal Comfort: Applicable requirements in ASHRAE 55.

F. ASHRAE ERV Testing: Applicable requirements in ASHRAE 84.

G. AHRI Rating: Applicable requirements in AHRI 1060.

H. UL listed and ETL performance certified.

2.3 CHASSIS

A. Cabinet: Sloped top, 0.052-inch- thick stainless-steel with removable front panel with concealed latches.

1. Mounting: On exterior wall.
2. Discharge Grille: Ducted supply.
3. Return Grille: Extruded-aluminum grille.
4. Finish: . Refer to Paragraph 2.8 for coating requirements.
5. Access Door: Hinged door in top of cabinet for access to controls.
6. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
7. Insulation: Cooling and heating sections fully insulated with 1-inch-thick fiberglass insulation.
8. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Wall Sleeves: Galvanized steel with polyester finish.

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with crankcase heater, liquid line filter dryer, externally equalized expansion valve, high-pressure switch, low-pressure switch, fan cycle, control, lockout relay, common alarm,] vibration isolation, and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins.
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: R-410A.

C. Indoor Fan: Forward curved, centrifugal; with twin variable-speed motor(s) and positive-pressure ventilation damper with electric operator.

D. Filters: 2-inch, pleated, disposable MERV 8, serviceable from front of the unit.

E. Condensate Drain: Coated stainless-steel drain pan and piping to direct condensate to dry well.

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: Manufacturer’s standard.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15042 "Common Motor Requirements for HVAC Equipment."

a. Fan Motors: Permanently lubricated split capacitor.
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.4 HEATING

A. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

2.5 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:

1. Low-Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.
2. Temperature-Limit Control: Prevents occupant from exceeding preset setup temperature.
3. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on outdoor coil and reverses unit to melt frost.

B. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage, adjustable thermostat with heat anticipator; heat-off-cool switch; and on-auto fan switch.

C. Outdoor Air: Motorized intake damper. Open intake when unit indoor-air fan runs.

D. Economizer Operation: Motorized intake-air damper controlled by an enthalpy sensor and a mixed-air sensor to provide natural cooling when the outdoor air temperature is favorable.

E. Dual Unit Control (DUC): Hinged cover with two-stage heat/cool thermostat with individual heat/cool setpoints, adjustable interstage differentials and bimetallic elements. The control shall feature a solid-state timer with 1-2-4-8 day sequence, unit lead selector, Unit 1 and 2 power-on LEDs, Unit 1 or 2 lead unit LEDs, 48-hour program save on loss of power, industry standard connections, and 24-volt power from each unit. The DUC shall provide auto sequencing and displays on status and operating status parameters.

F. Three-Phase Power Rotation Monitor: Three-phase monitoring to protect compressor from reverse rotation and to protect the unit from phase failure. Monitor manually reset.

G. Dehumidification Circuit: Supply-air stream, independent heat exchanger using a separate humidistat, hot gas three-way valve, separate desuperheating condenser circuit, and back drain orifice inserted between the reheat coil and suction line.

2.6 CAPACITIES AND CHARACTERISTICS

A. Refer to the equipment schedule on the Drawings.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

2.8 PAINTING AND COATINGS

A. Unless otherwise specified, all machinery and factory finished equipment such as pumps, fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped

galvanized or will have a factory applied finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified. All tanks, supporting steel, hangers, rods and all other uncoated or non-galvanized steel other than standard piping and fittings shall have a shop coat consisting of a suitable primer and finish coat. If not factory-applied, the prime coat shall be as specified in Division 9. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.

B. The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactures coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.

C. Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the Owner at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one pint, whichever is greater.

D. Where specified, or called for on the equipment schedules on the drawings, special corrosion resistant/protective coatings shall be provided. Whenever a protective coating is specified, the equipment shall be coated both inside and out. Whenever necessary to provide full coverage of the equipment, the equipment shall be completely disassembled to allow proper preparation and coating application. Any component that would block the coating process shall be removed. Equipment provided with gaskets or liners shall be coated before the application of the gasketing or liner. The equipment Vendor shall test rotating equipment after coating to confirm dynamic balance. If work needs to be done to correct the equipment balance, the integrity of the coating must be corrected after such work.

E. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

F. All items to be provided with a protective coating shall have the following data on the coating included with the unit submittal. Submittal shall include vendor data sheets on the specific coating being used, corrosion resistance data sheets, detailed application data sheets to include surface preparation procedures. For baked coatings submit a letter from the coating manufacturer, that the company doing the actual coating operation is an approved coating company. When an equipment supplier provides the coating, the information shall be supplied by the coating manufacturers.

G. Inspection and Preparation of Coil prior to Cleaning and Coating

1. Coil shall be inspected for fin damage. Bent fins shall be straightened using the proper fitting fin comb. Tubes and tube "U" bends shall be inspected for dents, punctures or pinched areas. Where possible, and with equipment manufacturer's approval bent, punctured, pinched tube or "U" bend areas shall be repaired and leak tested by coating vendor's A/C technician prior to coating. Vendor shall securely seal all open tubes to prevent the infiltration of dirt, water, cleaning and coating solutions into the tube. The

header tube shall be fitted with a Schrader valve and the coil placed under no less than 5 and no greater than 50 psi nitrogen blanket throughout the cleaning and coating process. The charge shall be recorded and verified following coating to ensure the coil was not damaged allowing cleaning or coating solutions to infiltrate the tube side.

H. Cleaning and Conditioning of the Coil Fin and Tube Surfaces Prior to Coating

1. Following initial preparation of the coil, the coil shall be thoroughly cleaned using a non-etching and non-oxidizing detergent solution having less than 10- ppm chlorides,and formulated for use on ferrous and non-ferrous metals to remove shop soils, dirt, grease and oils from the surface of the coil fins, tubes and casings. Following the detergent cleaning the coil shall be thoroughly rinsed using clean filtered water to flush off soils removed by the detergent. The surface to be water break free when rinsed ensuring a clean surface. A non-oxidizing chemical solution sealer shall then be applied to enhance adhesion and provide secondary corrosion protection. The coil shall then be dried at temperatures up to 220 degrees F until thoroughly dry prior to applying the coating.

I. Coatings shall be of the following types:

1. MANUFACTURER STANDARD COATINGS

a. Coating material shall be manufacturer's standard as specified in the schedule below. Surfaces shall be prepared, primed and coated as required be the coating supplier. Heat curing shall be provided where required by the coating supplier.

2. AIR DRIED PHENOLIC (equipment) TYPE 3A and TYPE 3B

a. Type 3A - Coating Material Heresite VR-507 air dried phenolic coating. The surface shall be prepared by degreasing with an appropriate solvent. Steel surfaces for non-immersion shall be sand blasted in accordance with NACE No. 3 or SSPC-SP6. Surface profile shall be 20 to 25 percent of dry film thickness. If blasting is not possible, the surface shall be primed with Heresite P-750 in accordance with the supplier's recommendations. Dry film thickness shall be 0.5 to 0.75 mills. Thinner where required shall be of the same manufacturer as the coating. Coating shall be applied by spraying in multiple passes. The piece shall be dried in accordance to the manufactures time schedule. The equipment shall be given a minimum of three coats resulting in a dry film thickness of 4 to 6mils. All equipment coated with VR-500 shall be given a topcoat of Heresite UC-5500. The UC-5500 series shall be applied by spraying and shall have a dry film thickness of 4 to 5 mils.

b. Type 3B - Coating material Husky SPC or Husky Pat Coat and Lin Coat from Bronz-Glow. When spray coating interior or exterior metal surfaces for corrosion protection vendor shall prepare the coated or uncoated metal surface in accordance with coating manufacture's specification. Coating shall have passed 3,000 hours salt spray test in accordance with ASTM B-117.85 Coating shall be a synthetic resin elastomer having a minimum 300% flexibility, 200% elongation, and effectively provide protection throughout the entire a pH range of 1.0-14.0. The coating shall be applied to a dry thickness of 4-6 mils. Coating to be field repairable in the event of damage to the coating. Following coating application coating shall be fully cured in accordance with manufacture's specifications prior to being placed in service or packaged for shipment.

c. Equivalent spray-on or roll-on cabinet coating products will be considered upon Engineer's review and approval of product data, application data, and corrosion resistance data.

3. AIR DRY SPRAY ON COATING (Equipment, coils, fins, etc.) TYPE 4A and TYPE 4B

a. Type 4A - Coating Material Adsil Micro Guard HVAC/R Coil and Fin Clear Protective Treatment AD35. Surface preparation, mixing and catalyzing, application, and clean-up shall be in strict accordance with the manufacturer's instructions. All recommended cleaning agents (Micro Kleen products) shall be utilized and applied per the manufacturer's instructions. Drying times and curing times shall be in accordance with the manufacturer's time schedule.

b. Type 4B- Coating Material Husky Coil Coat from Bronz-Glow. Prior to spray coat application the coil shall be cleaned and in accordance with the coating manufacture's specifications. Coil shall be allowed to dry thoroughly after cleaning prior to applying the coating. Coil shall receive corrosion protection treatment from a qualified coating vendor through application of vendor's in-house or field applied spray coating process. The coating material applied by this process shall have passed a minimum 3,000 hours salt spray test in accordance with ASTM B-117.85. Coating solution shall provide effective corrosion protection throughout the entire pH range of 1.0 to 14.0. Coating material shall consist of a synthetic polyelastomer material having properties of a minimum 5,000 psi tensile strength, 400% or greater flexibility, 250% or greater elasticity to prevent chipping, cracking or flaking, have negligible (less than 1/2 of 1%) effect on heat transfer coefficients, coating shall contain a UV inhibitor rated at 10-year Florida sun protection. The unit to be disassembled to the point to where the face of the coil from both sides are exposed and can be coated. The vendor shall further ensure the "U" bend and header areas shall also be exposed to allow maximum coating coverage on both the inner and outer radius of the "U" bend and header surfaces. The protective coating shall be applied by spray application on both sides of the coil and using a method that ensures maximum coating penetration into the fin area. Following curing of the coating the dry mill thickness shall not greater than 1½ - 2 dry mills. Following coating the coil shall be cured in accordance with coating manufacture's specification prior to restoring power to the unit. It is not recommended a coil of more than two rows be spray coated. Cabinet coating shall be Type 3B as described above.

c. Special care must be taken to follow coating manufacturer's instructions for coating coils to be sure that the entire surface of the fins and the tubes in the coil are coated. It is imperative that as much of the internal coil surfaces be coated as possible to prevent failure of the coil.

d. Equivalent spray-on coil coating products by Heresite (PC-2000 with PC-2000-C cabinet coating), Blygold (PoluAl coil coating with Type 3A or equal cabinet coating), Thermoguard (Total Coat), or equal will be considered upon Engineer's review and approval of product data, application data, and corrosion resistance data.

J. Coatings shall be factory applied by the equipment manufacturer/supplier. If this is not possible, coating shall be applied by a specialty shop under contract to the equipment manufacturer/supplier.

1. Corrosion protection shall be provided, by an authorized coating vendor for each applicable unit component as specified herein. A “Certificate of Coating Compliance” shall be issued by the coating vendor verifying use of the specified products and processes. Coating vendor shall supply owner a written “Owner’s Coated Coil Cleaning Service and Maintenance Manual”. Aforementioned certificate and manual shall be submitted upon completion of the project with all other closing documents.
2. Prior to shipment or installation of a coil into a cabinet coil shall be pressure tested to 110% of operating pressure and held for 45 minutes to ensure no leaks have occurred. Coil shall then be evacuated and placed under nitrogen blanket or installed in the cabinet.
3. When coil is being shipped as a single unit vendor shall protect coil tubes from soil or moisture infiltration by shipping coil under a nitrogen blanket of not less than 5 psi on the fluid side. Coil shall be tagged advising coil is under nitrogen blanket and psi rating of the nitrogen blanket.
4. Following installation of coil into the cabinet coating vendor’s a/c technician shall place coil under a 200-400 micron vacuum to ensure integrity of coil and absence of moisture within the coil.
5. Coil shall be issued a registration number and number shall be affixed to the coil by means of a non-removable polymer seal. Coating vendor shall maintain a job warranty file for each coil coated for the period of the warranty.
6. After coating application is completed, the equipment manufacturer/supplier shall test the equipment and certify system operation prior to releasing the equipment to the job site.

K. Any holidays, runs, sags, blisters, or inclusions in the coating are unacceptable and will be corrected. With the approval of the engineer, small areas no more than 4-in by 4-in may be corrected in the field. Larger faults shall be returned to the coater to be repaired. The faulty material shall be removed by sanding and in the case of blisters, the edges feathered. The material used for recoating shall be manufactured by the same manufacturer as the original coating and shall be suitable for field repairs. The touch up material shall have the same corrosion resistance as the original coating, and if the original coating required an ultraviolet protection, the same protection will be provided as part of the repair. The final mil thickness of the repaired coating shall be equal to the originally specified thickness. Where baked coatings have been damaged, the repair shall be made with heat applied to the repaired surface to cure the coating. After curing a solvent test as recommended by the manufacturer shall be used to confirm that the coating is cured.

L. The coating manufacturer shall supply direct to the engineer, a set of coupons showing the final appearance of the cured coatings. Any coating that does not match the supplied coupons will be rejected.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications shall be per the manufacturer’s recommendations for installation.

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Unit is level on base and is flashed in exterior wall.
4. Unit casing has no visible damage.
5. Compressor, air-cooled condenser coil, and fans have no visible damage.
6. Labels are clearly visible.
7. Controls are connected and operable.
8. Shipping bolts, blocks, and tie-down straps are removed.
9. Filters are installed and clean.
10. Drain pan and drain line are installed correctly.
11. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.
12. Installation: Perform startup checks according to manufacturer's written instructions, including the following:

    a. Lubricate bearings on fan.
    b. Check fan-wheel rotation for correct direction without vibration and binding.

13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. After performance test, change filters.

E. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged, terminal air conditioners.

END OF SECTION 15806

This page left intentionally blank.

SECTION 15905 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

2. Testing, Adjusting, and Balancing Equipment:

a. Motors.
b. Condensing units.

3. Testing, adjusting, and balancing existing systems and equipment.
4. Duct leakage tests.
5. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

A. Certified TAB reports.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.7 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.8 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine filters. Verify that startup filters have been replaced by permanent filters.

J. Examine control dampers for proper installation for their intended function.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete, and safeties are verified.

g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 15715 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 15091 "Duct Insulation," Section 15092 "HVAC Equipment Insulation," and Section 15093 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 15712 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.

3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.8 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean, and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.11 TOLERANCES

A. Set HVAC system's airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.12 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.

4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Engineer's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Balancing stations.
5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units and packaged units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Refrigerant expansion valve and refrigerant types.
    i. Refrigerant suction pressure in psig.
    j. Refrigerant suction temperature in deg F.
    k. Inlet steam pressure in psig.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units and packaged units, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Coil identification.
    d. Capacity in Btu/h.
    e. Number of stages.
    f. Connected volts, phase, and hertz.
    g. Rated amperage.
    h. Airflow rate in cfm.
    i. Face area in sq. ft..
    j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

    a. Heat output in Btu/h.
    b. Airflow rate in cfm.
    c. Air velocity in fpm.
    d. Entering-air temperature in deg F.
    e. Leaving-air temperature in deg F.
    f. Voltage at each connection.
    g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary airflow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final airflow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

3.14 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Engineer.

B. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 15905

This page left intentionally blank.

SECTION 16010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, and equipment required and install to make complete and operational electrical system including, but not limited to the demolition of all 2300V equipment, coordination of a new 480V electric service, and installation of new 480V switchboard, transformer, VFDs, soft starter, panelboard, lighting, and grounding at Fairfax Water's Reston Pump Station (PS) as a part of the electrical upgrades project as shown on the drawings and as specified.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:

1. Supplemental requirements generally applicable to the Work specified in Division 16. This Section is also referenced by related Work specified in other Divisions.

B. Related Requirements:

1. Section 16011 "Facility Performance Requirements for Electrical" for field conditions applicable to Work specified in this Section.
2. Division 03 “Concrete” for cast in place concrete work, including concrete encasements for electrical duct banks and equipment pads.
3. Division 02 “Site Construction” for excavation and backfilling, including gravel or sand bedding for underground work.
4. Division 13 “Special Construction” for SCADA, instrumentation, and process control equipment.
5. Section 01330 “Submittals” for Shop Drawing submittal procedures.
6. Section 01782 “Operation and Manual Data” for closeout submittals.

C. Electrical drawings are intended to show the general layout of work to be installed under this contract without attempting to show all details. Furnish labor, materials, equipment and incidentals required for a complete and operational electrical system as shown on the contract documents.

D. Coordinate work with other trades and the Owner.

E. Field verify existing underground electrical conduit, concrete duct banks, manholes, pull boxes, etc. and mechanical piping. Contractor shall include in bid costs associated with relocation or

removal of underground equipment as required by this contract. Use due care in congested areas to avoid damage to existing underground utilities.

F. Contractor's work shall include complete testing of equipment and wiring including making minor corrections, changes, or adjustments necessary for the proper functioning of the system and equipment. Workmanship shall be of the highest quality; substandard work will be rejected.

G. Scale electrical drawings for the electrical equipment. Refer to mechanical, structural drawings, and approved manufacturer's shop drawings for exact location of equipment. Except where dimensions are shown, locations of equipment, fixtures, outlets, and similar devices are approximate.

H. Work shall comply with NEC and Local Codes.

I. Do not splice conductors except as noted.

J. Power and control conduits shall have an equipment grounding conductor wire sized per Table 250.122 of the NEC (unless otherwise noted).

K. Repair, in accordance with specifications, sidewalks, walls, roadways, etc. Disturbed by construction activities whether or not shown for repair/repaving on civil drawings.

L. Conceal conduits to greatest extent practicable. Conduits run at existing structures shall be run exposed.

M. Where local disconnects and control panels are shown on plan views, locations are approximate. Adjust location as required to comply with NEC Article 110 for working clearances.

N. Do not install major conduit runs through areas designated for future structures.

O. Follow lockout-tagout procedures for de-energizing equipment before installing new equipment.

P. Provide rubber floor mats

1. Furnish and install a non-conductive elastomer compound rubber floor mat extending the full length and placed in front of and in back of each panelboard and control panel.
2. Mats shall be in accordance with ASTM D178, Type II, Class 2, 1/4-in thick minimum, 36-in wide with corrugated surface and shall be branded continuously on the back.
3. Mats shall have the following ratings:

    a. Voltage phase-to-phase 17,000 V RMS
    b. AC proof test voltage 20,000 V RMS
    c. DC proof test voltage 50,000 V Average

4. Type II mats shall be ozone, flame, and oil resistant.
5. Install mats in one continuous piece. Where equipment faces each other and is less than 6-ft apart, provide one width of mat.
6. Mats shall be stored without distortion, free from direct sunlight or sources of ozone and at a temperature not to exceed 95 degrees F (35 degrees C).

1.4 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. A: Ampere, unit of electrical current.
2. AC or ac: Alternating current.
3. AFCI: Arc-fault circuit interrupter.
4. AIC: Ampere interrupting capacity.
5. ASD: Adjustable-speed drive.
6. ATS: Automatic transfer switch.
7. AWG: American wire gauge; see ASTM B258.
8. BAS: Building automation system.
9. BIL: Basic impulse insulation level.
10. CB: Circuit breaker.
11. cd: Candela, the SI fundamental unit of luminous intensity.
12. CU or Cu: Copper.
13. DC or dc: Direct current.
14. DDC: Direct digital control (HVAC).
15. EGC: Equipment grounding conductor.
16. EPS: Emergency power supply.
17. EPSS: Emergency power supply system.
18. GEC: Grounding electrode conductor.
19. GFCI: Ground-fault circuit interrupter.
20. HP or hp: Horsepower.
21. HVAC: Heating, ventilating, and air conditioning.
22. Hz: Hertz.
23. IP: Ingress protection rating (enclosures); Internet protocol (communications).
24. IR: Infrared.
25. IS: Intrinsically safe.
26. kAIC: Kiloampere interrupting capacity.
27. kcmil or MCM: One thousand circular mils.
28. kV: Kilovolt.
29. kVA: Kilovolt-ampere.
30. kVAr or kVAR: Kilovolt-ampere reactive.
31. kW: Kilowatt.
32. kWh: Kilowatt-hour.
33. LAN: Local area network.
34. LCD: Liquid-crystal display.
35. LCDI: Leakage-current detector-interrupter.
36. LED: Light-emitting diode.
37. lm: Lumen, the SI derived unit of luminous flux.
38. LRC: Locked-rotor current.
39. LV: Low voltage.
40. MCC: Motor-control center.
41. MLO: Main lugs only.
42. MV: Medium voltage.
43. NC: Normally closed.
44. NO: Normally open.
45. OCPD: Overcurrent protective device.
46. PF or pf: Power factor.
47. PLC: Programmable logic controller.

48. PoE: Power over Ethernet.
49. PVC: Polyvinyl chloride.
50. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
51. RMS or rms: Root-mean-square.
52. RPM or rpm: Revolutions per minute.
53. SCADA: Supervisory control and data acquisition.
54. SPD: Surge protective device.
55. TCP/IP: Transmission control protocol/Internet protocol.
56. TEFC: Totally enclosed fan-cooled.
57. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.
58. UPS: Uninterruptible power supply.
59. USB: Universal serial bus.
60. V: Volt, unit of electromotive force.
61. VA: Volt-ampere, unit of complex electrical power.
62. VAR: Volt-ampere reactive, unit of reactive electrical power.
63. VFC: Variable-frequency controller.
64. VFD: Variable-frequency drive. See VFC.
65. W: Watt, unit of real electrical power.
66. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. ENT: Electrical nonmetallic tubing.
2. GRS: Galvanized rigid steel conduit.
3. IMC: Steel electrical intermediate metal conduit.
4. LFMC: Liquidtight flexible metal conduit.
5. PVC: Rigid PVC conduit.
6. PVC-40: Schedule 40 rigid PVC conduit.
7. RGS: Rigid galvanized steel conduit. See
8. RMC: Rigid metal conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CI: Circuit integrity cable.
4. CL2: Class 2 cable.
5. CL3: Class 3 cable.
6. CM: Communications general-purpose cable.
7. DG: Distributed generation cable.
8. IGS: Integrated gas spacer cable.
9. ITC: Instrumentation tray cable.
10. MC: Metal-clad cable.
11. MI: Mineral-insulated, metal-sheathed cable.
12. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
13. MV: Medium-voltage cable.
14. NM: Nonmetallic sheathed cable.
15. OFC: Conductive optical fiber general-purpose cable.
16. OFN: Nonconductive optical fiber general-purpose cable.
17. SE: Service-entrance cable.

18. SIS: Thermoset cable for switchboard and switchgear wiring.
19. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
20. THHW: Thermoplastic, heat- and moisture-resistant cable.
21. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
22. USE: Underground service-entrance cable.
23. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
2. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
3. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
4. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
5. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
6. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    c. Conduit Box: A box having threaded openings or knockouts for conduit, or fittings.
    d. Device Box: A box with provisions for mounting a wiring device directly to the box.
    e. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    f. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
    g. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for

mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.

h. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.

i. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

7. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

8. Jacket: A continuous nonmetallic outer covering for conductors or cables.
9. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
10. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
11. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
12. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
13. Sheath: A continuous metallic covering for conductors or cables.
14. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
15. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.

    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.

    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).

    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.

    e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.

f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

16. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.5 INTERPRETATION OF CONTRACT DOCUMENTS

A. If during performance of work, there is a conflict, error, or discrepancy between or among Contract Documents and laws and regulations, provide the higher performance standard unless otherwise directed by Engineer.

B. Priority of Documents: Figured dimensions govern over scaled dimensions, detailed drawings govern over general drawing, larger scale drawings take precedence over smaller scale drawings, change order drawings supersede original contract drawings, and contract drawings govern shop drawings.

C. In general, Drawings do not show conduit routing. Plan and route conduits in compliance with specifications and drawing details. Coordinate installation with other trades and actual supplied equipment.

D. Ductbank routing shown on electrical site plans is diagrammatic in nature and may not include interferences that may be present.

E. Refer to Electrical Legends and Abbreviations Sheets for additional notes.

1.6 COORDINATION

A. Refer Coordinate this article with Section 01110 "Summary of Work" to avoid conflicting requirements for utility service interruptions.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 PREINSTALLATION MEETINGS

A. Schedule Preconstruction Meeting and other Preinstallation Meetings in accordance with Project Meetings Section in Division 01.

1.8 SEQUENCING

A. Survey the existing electrical systems and equipment identified for removal with representatives from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

B. Where a piece of equipment is to be removed all associated ancillary components and associated wiring and conduit shall also be removed.

C. Conduct demolition to minimize interference with adjacent building areas.

D. Coordinate demolition work with other disciplines.

E. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.

F. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.

G. Shut-down Periods:

1. Arrange timing of shut-down periods of in service panels with Owner. Do not shut down any utility without prior written approval.
2. Keep shut-down period to minimum or use intermittent period as directed by the Owner.
3. Maintain life-safety systems in full operation.

H. Identify salvage items in cooperation with Owner.

I. Conduct and submit results of preliminary power system studies before submitting Product Data and Shop Drawings for electrical equipment.

J. Coordinate installation work with other trades.

1.9 SCHEDULING

A. Refer to Section 01140 “Limitations on Sequence of Construction”.

1.10 ACTION SUBMITTALS

A. Submit detailed Construction Schedule detailing equipment delivery, demolition of each equipment, installation of each equipment, testing per each individual equipment specification, inspection, and acceptance.

B. Submit Division 16 equipment and materials as specified in each Section at one time and not piecemeal. For example, all low voltage motor control centers on a project are to be submitted under one submittal number. Submittals that do not comply will be returned disapproved.

Subject to Engineer's approval, related items may be submitted together under one submittal. Contractor shall identify the multiple Sections included. For example, multiple Sections specify lighting fixtures and poles. A single submittal for lighting could be acceptable.

C. Submittals for certain major items such as switchboard, transformers, soft starters, and variable frequency drives shall include a complete copy of their specification section with each paragraph and sub-paragraph noted with the comment "compliance", "deviation", or "alternate".

1. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term "deviation", it shall be understood that the manufacturer prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the owner.
3. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so doing, takes full responsibility for making the equipment work as specified and will provide and all ancillary components to make the equipment work at no extra cost to the owner. The alternate method shall be fully described with Schematic Diagrams and One-Line Diagrams as applicable.

D. Mark submittals to clearly identify proposed equipment including accessories, options, and features and cross out information not applicable to the project to make the Shop Drawing project specific. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means and cross out all other options and accessories that will not be included in the project. Generic catalog cuts will not be accepted.

E. Submit conduit shop drawings for yard electrical, within and under roads, buildings and structures prior to commencing work. Do not pour concrete until engineer has approved the associated shop drawing.

F. Submit power system study in accordance with Section 16071.

G. Submit Operation and Maintenance Manuals for equipment furnished under Division 16 in accordance with Section 01782 and their individual sections.

H. Submit startup/commissioning plans for equipment furnished under Division 16.

I. Submit testing and service reports for equipment and materials furnished under Division 16.

J. Submit training plans for equipment furnished under Division 16.

K. Submit record documentation to accurately show completed installation. Include modifications to contract documents (One-Line Diagrams, Equipment Elevations, Panelboard Schedules, Schematic Diagrams, Riser Diagrams, Plan Views, conduit and ductbank routing, etc) along with additional drawings or sketches created to convey completed installation.

L. Electrical Installation Drawings:

1. Drawings in general do not show conduit routing other than major conduit and ductbank routes. Submit conduit layouts for exposed, concealed, and buried conduits.
2. Submit pump room layout using approved shop drawing dimensions for equipment.
3. Submit layouts at an appropriate scale for clarity.
4. Include type written conduit schedules for easy cross check.
5. Installation submittal drawing must be approved before concrete pours are made that will conceal conduits.

M. Training Plans: Submit instructional program outline for Engineer's review and approval, where demonstration and/or training is specified.

1.11 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Engineer including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 16.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 16.
7. Utility service outages.
8. Utility service inspection and activation.
9. Closing of walls and ceilings containing electrical Work.
10. System startup, testing, and commissioning activities for major electrical equipment.
11. System startup, testing, and commissioning activities for emergency lighting.
12. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
13. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
14. Requests for special inspections.
15. Requests for inspections by authorities having jurisdiction.

B. Delegated Design Drawings: As indicated in individual Division 16 Sections.

C. Seismic Qualification Data: In accordance with Section 16011 "Facility Performance Requirement for Electrical" and individual Division 16 Sections.

D. Qualification Statements: In accordance with individual Division 16 Sections.

1.12 CLOSEOUT SUBMITTALS

A. Record Documents: Submit documentation to accurately show completed installation. Include modifications to Contract Documents (one line power diagrams, equipment elevations, panel schedules, elementary control diagrams, riser diagrams, plans, conduit and ductbank routing, etc.) along with additional drawings or sketches created to convey completed installation.

B. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device as specified in each Division 16 Section as specified in Specification Section 01330 “Submittals”, 01782 “Operation and Maintenance Data”, and each individual section.

1.13 DELEGATED DESIGN / PROFESSIONAL ENGINEERING SERVICES

A. When engineering services are specified to be provided by Contractor, retain a licensed professional engineer to perform the services. Engineer shall be licensed at the time services are performed and licensed in the state in which project is located. If the state issues discipline specific licenses, Engineer shall be licensed in the applicable discipline. Engineer shall be experienced in the type of work being performed.

B. Engineering work shall be done according to the applicable regulations for professional engineers to include signing, sealing, and dating documents.

1.14 QUALIFICATIONS

A. Comply with Quality Assurance Articles within each Division 16 Section.

B. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.15 MATERIALS AND EQUIPMENT

Provide new materials and equipment unless specifically noted otherwise.

A. Provide the following NEMA type electrical enclosures, unless otherwise noted:
1. NEMA 4X Type 316 stainless steel in outdoor locations, and "damp" or "wet" locations shown on the drawings.

B. Electrical materials and equipment must be listed by Underwriter’s Laboratories, Inc. (UL**)** or other National Recognized Testing Laboratory (NRTL) and bear the appropriate listing or classification marking. Equipment not bearing a UL certification shall be field or factor UL certified prior to acceptance and use.

C. Provide major electrical equipment by a single manufacturer, i.e. switchboards, disconnect switches, transformers, panelboards, etc.

D. Variable frequency controllers, when provided as a stand-alone package with the driven equipment and therefore not included in a motor control center are not to be required to be by a single manufacturer.

E. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room or as directed by Owner's Representative.

1.16 EQUIPMENT SIZE, HANDLING, AND STORAGE

A. Coordinate with equipment manufacturer shipping splits to permit safe handling and passage of equipment to final installation location.

B. Comply with manufacturer's instructions for upright equipment orientation during transportation.

C. Protect equipment from mechanical injury, or exposure to moisture, chemicals, or corrosive gases. Do not store indoor rated electrical equipment outdoors.

D. Provide and energize temporary space heaters if required to control moisture during storage.

1.17 SERVICE AND METERING

A. Electric power company serving this project is Dominion Energy . Power company contact is Liv Hoffman with the following contact information: Telephone Number (703) 298-0033, email liv.g.hoffman@dominionenergy.com. Comply with power company standards.

B. Pay fees and charges as required for temporary / construction power for Contractor's use.

C. Pay fees and charges as required for permanent service via a bid allowance and submit power company invoices to owner for substantiation.

D. Power Company Work:

1. Furnish conduit materials for underground service to utility transformer.
2. Provide primary conductors (overhead and underground) to utility transformer.
3. Provide utility transformer pad and grounding.
4. Provide utility transformer.
5. Terminate underground primary cables at the utility transformer.
6. Terminate underground secondary cables at the utility transformer.
7. Provide metering current transformers (CT's), meter and meter wiring.

E. Contractor Work:

1. Make arrangements with power company to obtain service, pay power company fees, and provide labor and materials required for electrical service.
2. Install primary underground conduits.
3. Provide secondary underground conduits and cable from utility transformer to service entrance equipment.
4. Terminate secondary underground cables at the service entrance equipment.
5. Provide power company approved metering current transformer (CT) enclosure.
6. Install meter base enclosure.
7. Provide empty conduit with pull line from the metering CT enclosure to the meter base enclosure.

1.18 FIELD CONDITIONS

A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 16 must comply with requirements specified in Section 16011 "Facility Performance Requirements for Electrical."

B. Service Conditions for Electrical Power Equipment: Besides conditions specified in Section 16011 "Facility Performance Requirements for Electrical," specified electrical power equipment must be suitable for operation under service conditions specified as usual service conditions in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards.

1.19 ELECTRICAL SYSTEM TESTING AND SETTINGS

A. Test electrical systems and equipment in accordance with individual sections. This includes motors or other electrical equipment which are not specified in Division 16.

B. Set and adjust controls, timers, relays, adjustable trip units, protective devices, and other electrical components in accordance with manufacturers instructions and the approved power system study. Do not energize equipment without correctly setting adjustable components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 REMOVAL AND DISPOSAL OF LEGALLY REGULATED MATERIALS

A. Material and equipment indicated to be removed and disposed of will become the Contractor's property. Dispose of material and equipment offsite, unless otherwise directed by the Owner. Provide the Owner with a receipt indicating the acceptable disposal of any legally regulated materials or equipment.

B. Assume that the ballasts in each existing lighting fixture contain PCB's, unless specifically marked with a label indicating "No PCBs." Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility; pay all shipping, packaging and recycling costs.

C. Remove, package, ship and dispose of PCBs, mercury and PCB/mercury contaminated equipment, in accordance with all State and Federal regulations. Retain the services of a firm licensed and regularly engaged in the removal of PCBs and PCB contaminated equipment. Retain a firm licensed in the State or States in which the contaminated material is handled, shipped and disposed of. Pay all fees associated with the removal of the contaminated material and equipment. Submit documentation indicating acceptable disposal.

D. If PCB’s or mercury contaminated equipment are discovered that were not identified; cease work on or about the equipment and notify the Owner Representative immediately.

3.2 DEMOLITION

A. Maintain temporary safeguards including egress signage and emergency lighting.

B. All electrical demolition, including lock-out tag-out procedures, shall be overseen by a licensed electrician.

C. Drawings showing removal of major mechanical and electrical equipment is not intended to show all components to be demolished. Not all piping, conduits, ducts, equipment, ancillary devices, etc. are shown. Field verify existing conditions prior to bid.

D. Verify wiring and equipment indicated to be demolished serve only abandoned facilities as shown on the Drawings.

E. Verify termination points for demolished services.

F. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

G. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to source and/or point of concealment including above accessible ceiling finishes. Wiring shall be removed.

H. Cut flush with slab, ceiling, or wall abandoned concealed conduit. Suitably plug conduits.

I. Repair and restore adjacent construction and finishes after demolition is complete.

J. Material and equipment indicated for removal or demolition is to become the Contractor's property upon removal, unless noted otherwise. Removed material to be properly handled and disposed.

K. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.

L. Reconnect equipment being disturbed by renovation work and required for continue service to nearest available panel.

M. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring as shown on the Drawings.

N. Install temporary wiring and connections to maintain existing systems in service during construction.

O. Perform work on energized equipment or circuits with experienced and trained personnel.

P. Remove, relocate, and extend existing installations to accommodate new construction.

Q. Repair adjacent construction and finishes damaged during demolition and extension work.

R. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components. Cut embedded support elements flush with walls and floors.

S. Clean and repair existing equipment to remain.

T. Protect and retain power to existing active equipment remaining.

U. Install pull strings in abandoned conduits and cap at both ends.

3.3 EXISTING PANELBOARDS

A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.

B. Tag unused circuits as spare.

C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.

D. Remove existing wire no longer in use from panel to equipment.

E. Provide new updated directories where more than three circuits have been modified or rewired.

3.4 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place sleeves for conduits and slots for electrical work prior to concrete pour.

B. Use approved shop drawings and equipment vendor templates to determine exact locations for stub-ups and terminating concealed conduit and place before floor slab pour.

C. Seal openings, sleeves, penetration and slots in accordance with Section 16000 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling.”

3.5 CUTTING AND PATCHING

A. Cut and patch in a workmanlike manner as required to install electrical work.

B. Modify concrete in accordance with Division 3 “Concrete.”

C. Do not cut joists, beams, girders, columns, or other structural members.

D. Patch surfaces to restore to original integrity (waterproof or fireproof as required) and appearance.

E. Core drill holes in concrete floors and walls as required. Prior to coring concrete, scan slab or wall using radar to locate and identify rebar and/or conduit and wiring. Locate cores to avoid cutting or drilling through rebar and/or conduits. Space conduits to not weaken structural integrity. Notify Engineer immediately if rebar is cut or upon becoming aware of discrepancies within area of work.

3.6 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 16. Consult Engineer for resolution of conflicting requirements.

3.7 FIELD QUALITY CONTROL

A. Field testing, startup services, and system functional testing may be provided by the Contractor, and/or the manufacturer’s factory-authorized service representative, and/or an independent testing agency. Provide testing and/or startup service as specified in the relevant section.

B. Submit Field Quality-Control Report as informational submittal within 14 days of each completed test or startup. Include within the report adjustments / as left settings.

3.8 CLEANING

A. Remove rubbish and debris from inside and around electrical equipment and enclosures.

B. Remove dirt, dust or concrete spatter from interior and exterior of equipment using brushes, vacuum cleaner, or clean lint-free rags. Do not use compressed air.

3.9 CLOSEOUT ACTIVITIES

A. Provide demonstration and training as specified in each section.

END OF SECTION 16010

SECTION 16011 - FACILITY PERFORMANCE REQUIREMENTS 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 SUMMARY

A. Section Includes:

1. Field conditions and other facility performance requirements applicable to Work specified in Division 16.

1.3 FIELD CONDITIONS

A. Altitude:

1. Sea level to 1000ft

B. Ambient Temperature:

1. 0 to 40 deg C.

C. Humidity:

1. Less than 90 percent (non-condensing).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 16011

This page left intentionally blank.

SECTION 16052 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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

1. Encore Wire Corporation.
2. Okonite Company (The).
3. Service Wire Co.
4. Southwire Company, LLC.

B. Stranding: Refer to CONDUCTOR APPLICATIONS Article in PART 3.

1.2 Type TRAY CABLE, TYPE TC-ER FOR VFC (VFD) APPLICATIONS

A. Type TC-ER: Shielded, stranded, tinned copper cable with three symmetrical ground conductors, XLPE insulation, PVC outer jacket, designed for use as output cable to motor from VFCs.

1. Nexans AmerCable Type 37-108VFD Flexible TC-ER VFD Power Cable or equal.
2. Conduit sizing on Drawings are based on using this manufacturer. Increase conduit size as required to comply with NEC if different manufacturer is submitted.
3. Nexans AmerCable Data:

	Grounding Conductors (x 3) Size (AWG)	Nominal Diameter (inches)	Nexans AmerCable Part Number
12	16	0.509	37-108-516VFD
10	14	0.522	37-108-308VFD
8	14	0.653	37-108-309VFD
6	12	0.737	37-108-310VFD
4	12	0.956	37-108-312VFD
2	10	1.103	37-108-314VFD
1	10	1.221	37-108-315VFD
1/0	10	1.447	37-108-316VFD
2/0	10	1.538	37-108-317VFD
4/0	8	1.883	37-108-319VFD

1.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Tin-plated copper.
2. Type:

    a. One hole with long barrels for No. 8 AWG to No. 4/0 AWG.
    b. Two holes with long barrels for 250 kcmil and larger.
    c. Locking spade for No. 10 AWG and smaller.

3. Termination: Compression for No. 8 AWG and larger.

D. Connectors:

1. Solderless pressure type (wirenuts) for No. 10 AWG and smaller.
2. Pre-filled with silicone-based sealant for exterior, wet, or corrosive locations.
3. Split bolt type for No. 8 AWG and larger splices.

E. Motor Terminations: Mechanical compression ring type, secured with bolt, nut and spring washer.

PART 2 - EXECUTION

2.1 CONDUCTOR APPLICATIONS

A. Wires and Cables: Copper; stranded, except for lighting and receptacle wiring which may be solid. Minimum size for power circuits: No. 12 AWG.

B. Nominal 480/277VAC Power Circuits: Single conductors in raceway. Type XHHW-2.

C. Nominal 240/208/120V Power Circuits: Single conductors in raceway. Type XHHW-2.

D. Direct Burial Outdoor Lighting Circuits: Type RHW-2.

E. Grounding Conductors: Refer to Section 16056 “Grounding and Bonding for Electrical Systems”.

F. VFC Output Circuits: Type TC-ER with shield.

2.2 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points in accordance with Section 16131 "Conduits for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Use of steel fish tapes and/or steel pulling cables in PVC conduit or raceways that terminate into energized enclosures is prohibited.

F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

G. Support cables according to Section 16057 "Hangers and Supports for Electrical Systems."

2.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Do not splice service or feeder cables without prior written approval of Engineer.

C. Wiring at Outlets:

1. Install conductor at each outlet, with at least 6 inch of slack.
2. Form solid wire into loop to fit around device terminal screw. Do not overlap wire.

2.4 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 16070 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16064 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

2.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance, and feeder conductors, and 480V power circuit conductors for compliance with requirements.
2. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 1000 V(dc) for 600 V rated cable for a one-minute duration. Minimum wire insulation resistance: 250 Megohms.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 16052

SECTION 16055 - CONTROL-VOLTAGE ELECTRICAL POWER 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 SUMMARY

A. Section Includes:

1. Category 6a balanced twisted pair cable.
2. Control-circuit conductors.
3. Instrumentation cable.
4. Termination products.

B. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: Manufacturer’s cut sheet for each type of product used on project.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100 ohm, No. 23 AWG solid copper.

D. Shielding/Screening: Shielded twisted pairs (FTP).

E. Cable Rating: Riser.

F. Jacket: Yellow thermoplastic.

2.3 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

2.4 CONTROL-CIRCUIT CONDUCTORS

A. Individual Conductors: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Minimum Size: No. 14 AWG for 120V circuits, No. 16 AWG for circuits 50V and less.

2.5 INSTRUMENTATION CABLE

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

1. Belden.
2. Rockbestos-Suprenant Cable Corp.

B. Single or Multiple Paired Cable: NEC Type ITC (Instrumentation Tray Cable), UL Type TC for 4-20mA process instrumentation signals and use under NEC Article 727.

1. One or Multi-pair, twisted, shielded, No. 16 AWG, stranded, tinned-copper conductors.
2. Voltage Rating: 600V.
3. Insulation: PVC.
4. Shield: 100 percent aluminum/polyester foil with drain wire. Pairs individually shielded.
5. Jacket: PVC with manufacturer's identification.
6. Standards: UL 1277 Type TC, UL 1581.
7. Single pair cable maximum overall diameter: 0.297-inches.

2.6 TERMINATIONS

A. Termination connectors for instrumentation and control conductors:

1. Tin plated copper.
2. Vinyl insulated.
3. Flanged spade / locking fork with upturned leg ends.
4. Crimp / compression installation.

B. Termination connector for industrial Ethernet cable: match conductor count, RJ45 type, intended for shielded cable. Rockwell Automation Bulletin 1585J or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 16131 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

B. Comply with requirements in Section 16059 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.

1. Outlet Boxes: No smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet Boxes for Cables: No smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit isnot allowed.

C. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows if possible.

E. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96 inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with requirements in Section 16052 “Low-Voltage Electrical Power Conductors and Cables” for installation requirements and as supplemented or modified in this Section.

B. Instrumentation wiring, including control and monitoring wiring, and Ethernet cables may not be spliced and are to be continuous from terminal to terminal.

C. Install instrumentation and Ethernet cabling in separate raceway from control or power wiring. Install analog signal wiring in separate raceway from digital signal or control wiring.

D. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

E. Separation from EMI Sources:

1. Separation between open instrumentation cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment as follows:

    a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 16056 "Grounding and Bonding for Electrical Systems."

C. For instrumentation wiring, ground shield at one end only as recommended by instrument manufacturer and in accordance with Owner’s standard.

3.6 IDENTIFICATION

A. Comply with requirements for identification specified in Section 16070 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers comply with UL 969, for label stocks, laminating adhesives, and inks.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.7 FIELD QUALITY CONTROL

A. and "Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 16055

This page left intentionally blank

SECTION 16056 - 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 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding materials and hardware.
3. Grounding (earthing) electrodes.

B. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product used on the project.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Insulated Grounding and Bonding Conductor: Copper conductor, 600V with insulation type matching the circuit phase conductors called for in Section 16052 “Low-Voltage Electrical Power Conductors and Cables”, green color.

B. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ERICO; brand of nVent Electrical plc.
    b. Harger Lightning & Grounding; business of Harger, Inc.

2. Referenced Standards: Complying with one or more of the following:

    a. Soft or Annealed Copper Wire: ASTM B3.
    b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
    c. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 GROUNDING AND BONDING MATERIALS AND HARDWARE

A. Performance Criteria:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

B. Ground Rods: Copper clad steel, 3/4-inch by 10-feet, sectionalized as required by Drawings.

C. Grounding Conduit Hubs: Malleable iron type.

D. Water Pipe Ground Clamps: Cast bronze saddle type.

E. Exothermic-welding Kits: CADWELD process or equal.

    a. Manufacturer kits to include molds and powder recommended by kit manufacturer for materials being joined and installation conditions.
    b. Welds used indoors in occupied buildings or confined space to be low emission type, CADWELD EXOLON or equal.

F. Ground Rod Test Wells: As detailed on the Drawings.

G. Bus Bars: Rectangular bar of annealed copper. As detailed on the Drawings.

PART 3 - EXECUTION

3.1 SELECTION OF GROUNDING AND BONDING CONDUCTORS

A. Conductors: Install solid conductor for 10 AWG and smaller, and stranded conductors for 8 AWG and larger unless otherwise indicated.

B. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.

C. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.

D. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

E. Underground Grounding Conductors: Install bare copper conductor, size as indicated on Drawings.

1. Bury at least 30 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

3.2 SELECTION OF CONNECTORS

A. Conductor Terminations and Connections:

1. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
2. Connections to Ground Rods at Test Wells: Bolted connectors.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Engineer for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding Electrode Conductors:

a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

b. Where conductors pass through floor slabs, walls, etc., install in conduit or sleeve.
c. When conductors need to be installed in conduit for mechanical protection, use non-ferrous conduit to avoid a choke effect for fault currents.

2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

3. Electrodes:

a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.

1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2) Use exothermic welds for below-grade connections.
3) Drive rods vertically and do not allow them to be deformed or driven at an angle. Where driving is difficult or rock is encountered, use purpose-designed drilling equipment, install rod into drilled hole and backfill around rod using ground enhancement material (GEM) mixed with water to form a slurry in accordance with manufacturer’s instructions.

b. Test Wells: Install as indicated on Drawings. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each steel column or other indicated item, extending around perimeter of building, area, or item indicated.

1) Bury ring electrode not less than 24 inch from building's foundation.
2) Lay underground conductors slack, and where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe or other magnetic material, electrically connect conductors to both ends of the guard.

c. Concrete-Encased Electrode (Ufer Ground): Fabricate in accordance with NFPA 70.

4. Grounding at Service:

   a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.

5. Grounding Separately Derived Systems:

   a. Transformers: Bond neutral and ground with a bonding jumper at the equipment in accordance with NEC 250.102. Connect to the grounding electrode system via the electrode grounding conductor in accordance with NEC Table 250.66 or as indicated on the Drawings.
   b. Generators and UPS: When indicated on the Drawings as a separately derived system, bond neutral and ground with a bonding jumper at the equipment in accordance with NEC 250.102. Connect to the grounding electrode system via the electrode grounding conductor in accordance with NEC Table 250.66 or a indicated on the Drawings.
   c. Generator: Install grounding electrode(s) at generator location. Electrode must be connected to equipment grounding conductor and to frame of generator.

6. Grounding Underground Distribution System Components:

   a. Comply with IEEE C2 grounding requirements.

7. Grounding and Bonding Manholes and Handholes: Install as indicated on Drawings. Bond exposed-metal parts to ground rod or grounding conductor. Grounding and Bonding of Raceways, Cable Trays, Boxes, and Enclosures:

   a. Terminate metallic conduit into pressed steel boxes using double locknuts (same metal type as conduit) and insulated grounding bushings.
   b. Terminate metallic conduit into metallic gasketed enclosures using Meyers grounding type conduit hubs.
   c. Use insulated throat grounding bushings with lay-in type lugs to terminate metallic conduits containing equipment grounding conductors into sheet steel boxes.
   d. Bond metallic electrical system components such as cable trays, supports, brackets, braces, boxes, etc. to the raceway system if they are not rigidly secured to and in contact with the raceway system or are subject to vibration and loosening.
   e. Provide a bonding jumper across hinged metal panels or doors when electrical components in excess of 24 volts are mounted on the moveable panel.
   f. Provide a grounding bushing at the end of metallic conduits that terminate in free air.
   g. Provide 12 AWG insulated green wire bonding jumper for metal outlet boxes that contain receptacles. Connect wire from receptacle ground terminal to box using grounding screw.

8. Equipment Grounding:

   a. Install insulated equipment grounding conductors with feeders and branch circuits.

b. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
c. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
d. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.
    d. Test continuity where the existing ground cables are intercepted and/or extended to the point measured/confirmed to be connected to the GEC.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω (ohms).
    b. Power and Lighting Equipment or System with Capacity over 500 kVA: 5 Ω (ohms).

3.5 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 16056

This page left intentionally blank.

SECTION 16057 - HANGERS AND SUPPORTS 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 SUMMARY

A. Section Includes:
   1. Conduit and cable support devices.
   2. Support, anchorage, and attachment components.
   3. Fabricated metal equipment support assemblies.

B. Related Requirements:
   1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product used on the project.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following: channel support systems, conduit support hardware, and accessories.
   2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics for Nonmetallic Channel Systems and Accessories: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame Rating: Class 1.
   2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Conduit Supports:

1. Trapezes:

a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.

b. PVC coated steel beams, channels, struts or stainless steel channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

2. Flush Mounted Supports:

a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.

b. PVC coated steel channels, struts or stainless steel channels, struts with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

3. Conduit Racks:

a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.

b. PVC coated steel conduit racks or stainless steel conduit racks with stainless, accessories and components shall be shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

4. Conduit Hangers:

a. In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel.

b. Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

B. Stainless Steel Channel:

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Stainless steel, Type 304.

C. Hot-dipped Galvanized Steel Channel:

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Hot-dipped galvanized steel.

D. Accessories: Conduit clamps, straps, hangers, rods, backplates, anchors, nuts, washers, etc. to correspond with channel material as listed in the SELECTION Article. Use of galvanized steel components is only allowed with galvanized steel channel.

E. Threaded Rod: 3/8-inch diameter, minimum.

F. Expansion Anchors: 3/8-inch minimum diameter. Equal to “Kwik Bolt”, manufactured by McCullock Industries; “Wej it” manufactured by Wej it Expansion Products; or “Kwik-Bolt II” manufactured by Hilti Fastening Systems.

PART 3 - EXECUTION

3.1 SELECTION OF CHANNEL

A. Dry, indoor, conditioned, non-process space: Hot dipped galvanized steel.

B. Outdoor, process areas, or areas indicated on Drawings as “DUST”, “DAMP”, or WET”: stainless steel, depending upon load requirements.

3.2 INSTALLATION

A. Comply with the following standards as applicable for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101: Standard for Installing Steel Conduits.
2. NECA NEIS 102: Standard for Installing Aluminum Rigid Metal Conduits.
3. NECA NEIS 105: Standard for Installing Metal Cable Tray Systems.
4. NECA NEIS 111: Standard for Installing Nonmetallic Raceways.

B. Attach support systems only to structural components. Use concrete expansion anchors for attachment to concrete surfaces.

C. Provide a minimum of 1/2-inch clearance between wall and equipment when installing surface mounted panel boxes, junction boxes, conduit, etc.

D. Space conduit supports, other than for underground raceways, at no more than 8 foot intervals, and as required to obtain rigid construction.

E. Remove burrs and grind smooth sharp edges from channel support ends. Fit ends with plastic end caps.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 16057

This page left intentionally blank.

SECTION 16059 - BOXES AND COVERS 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 SUMMARY

A. Section Includes:

1. Conduit bodies.
2. Metallic outlet boxes, device boxes, rings, and covers.
3. Nonmetallic outlet boxes, device boxes, rings, and covers.
4. Junction boxes and pull boxes.
5. Cover plates for device boxes.
6. Hoods for outlet boxes.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 16070 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product used on the project.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Listing Criteria as Applicable:

1. UL 514A – Metallic Outlet Boxes.
2. UL 514B – Conduit, Tubing, and Cable Fittings.
3. UL 514C – Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
4. UL 514D – Cover Plates for Flush-Mounted Wiring Devices.
5. UL BGUZ – Junction and Pull Boxes.
6. UL QCIT – Metallic Outlet Boxes.
7. UL QCMZ – Nonmetallic Outlet Boxes.

2.2 CONDUIT BODIES

A. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point.

B. Listed and labeled for type of conduit, location, and use. Refer to Section 16131 “Conduits for Electrical Systems” for conduit types and fittings used on the project.

C. Use mogul type (with rollers) for metal conduit bodies sizes 2-1/2 inch and larger by Appleton Electric.

2.3 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Outlet and Device Box Description: Box having pry out openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover. Outlet boxes do not include provisions to mount devices. Device boxes include provisions to mount a device to the box.

B. Extension Ring Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

C. Pressed Steel Boxes: Hot dipped galvanized with hot-dipped galvanized tile rings. For use when recessed in walls or indoors exposed in non-process ceiling areas.

1. Lighting outlet boxes: 4-11/16 inch square, 2 1/8 inch deep, minimum.
2. Device boxes with electronics device (i.e. smart switch or receptacle, occupancy sensor, dimmer, etc.): Largest size for number of gangs required.

D. Cast Boxes: Type FD (deep) only. Type FS not permitted. Copper free aluminum. PVC coated when used with PVC coated conduits. Gasketed cover when used outdoors. Stainless steel screws for covers.

E. Pedestal Device Boxes: Cast aluminum, polished finished. Used for laboratory bench receptacles.

F. Floor Boxes: Concrete tight. Number and type of devices as indicated on Drawings.

2.4 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Outlet and Device Box Description: Box having pry out openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover. Outlet boxes do not include provisions to mount devices. Device boxes include provisions to mount a device to the box.

B. Only allowed in conjunction with PVC schedule 80 exposed conduit installations.

C. Type FD (deep) box only. Type FS (shallow) box not allowed.

2.5 JUNCTION BOXES AND PULL BOXES

A. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

B. NEMA 1 and NEMA 12 Junction and Pull Boxes:

1. Material: Sheet steel, minimum 14 gauge, without knockouts.
2. Construction: Flanged box, galvanized with continuous weld seams that are ground smooth.
3. Cover: Gasketed, hinged, fastened with quick connect door clamp.

C. NEMA 4X Junction and Pull Boxes:

1. Material: Type 316 stainless steel, minimum 14 gauge, without knockouts.
2. Construction: Flanged box, continuous weld seams that are ground smooth.
3. Cover: Gasketed, hinged, fastened with quick connect door clamp.

D. NEMA 4X Chemical Area Junction and Pull Boxes: When Drawings classify the area as CORROSIVE, ultraviolet resistant fiberglass reinforced plastic (FRP) with stainless steel hardware and gasketed covers.

2.6 COVER PLATES FOR DEVICES BOXES

A. Single Source: Obtain wall plates from same manufacturer of wiring device.

B. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Flush Mounted Devices in Indoor Industrial Spaces: Includes electrical rooms, mechanical rooms, janitor closets, and indoor process areas. Type 302 (18-8) high nickel stainless steel.
3. Material for Surface Mounted Devices: Match box material.

2.7 HOODS FOR OUTLET BOXES

A. Description: Hood to mount to box for to create weatherproof while in use condition.

B. Wet-Location, Weatherproof Cover Plates (Hoods) for Switches and Receptacles: NEMA 250, complying with Type 3R, in-use weather-resistance, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Engineer for resolution of conflicting requirements.

B. Conduit bodies: Match associated conduit type.

C. Outlet boxes recessed in walls or indoors exposed in non-process ceiling areas: Pressed steel.

D. Exposed outlet and device boxes: Cast metal except where PVC-80 is used. Use PVC coated cast metal when conduit is PVC coated. Use non-metallic when PVC-80 is used.

E. Junction and pull boxes: Suitable for the location and conform to the NEMA enclosure ratings and material descriptions included on Drawings. Where no size is indicated, size in accordance with NEC Article 314.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for wallplates and covers.

14. Identification: Install labels and nameplates in accordance with Section 16070 “Identification for Electrical Systems”.

3.3 CLEANING

A. Remove construction dust and debris from boxes before installing wall plates, covers, and hoods.

3.4 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 16059

This page left intentionally blank.

SECTION 16063 - UNDERGROUND DUCTS AND RACEWAYS 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 SUMMARY

A. Section Includes: Manholes, handholes, and duct accessories.

B. Products Installed, but Not Furnished, under This Section:

1. Section 16131 “Conduits for Electrical Systems” for conduits.
2. Section 16070 "Identification for Electrical Systems" for underground-line warning tape.

C. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Division 03 for concrete and reinforcing steel.
4. Division 02 for groundwater control, trenching, excavation and backfilling including gravel and sand bedding, and surface restoration.

1.3 DEFINITIONS

A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.

B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.

C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.

D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include accessories for manholes and handholes.
3. Include underground-line warning tape.

B. Shop Drawings:

1. Handholes or Manholes:

a. Include plans, elevations, sections, details, and accessories.
b. Include duct entry provisions showing locations and duct sizes.
c. Include frame, cover, entry extensions if applicable, and grounding details.
d. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

2. Underground Conduit Layouts: In accordance with Section 16131 “Conduits for Electrical Systems”.

3. Electric Utility Duct Banks and Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Indicate locations of private property boundaries and utility easements.
c. Include information required for approval by electric utility and for obtaining public space utility work permits.

1.5 INFORMATIONAL SUBMITTALS

A. Buoyancy calculations for manholes. Calculations must be signed and sealed by a qualified professional engineer.

B. Field quality control reports.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Comply with Section 16131 “Conduits for Electrical Systems” for conduits and fittings.

2.2 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: In accordance with Section 16070 "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.

1. Load Rating: Class H-20.
2. Cover Legend: “ELECTRIC”, unless otherwise indicated.
3. Comply with details shown on Drawings.

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

1. Oldcastle Infrastructure.
2. Concast, Inc.

C. Cover: Rectangular cover with hinged lid and hold-open mechanism. Padlockable hasp. Removable meter lid for cables to run through the top of the handhole cover.

D. Comply with ASTM C858 “Standard Specification for Underground Precast Concrete Utility Structures” for design and manufacturing process.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Engineer if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.

C. Clear and grub vegetation to be removed, and protect vegetation to remain, and remove and stockpile topsoil for reapplication in accordance with Section 02200 “Site Clearing.”

3.2 SELECTION OF UNDERGROUND DUCTS

A. Concrete Encased Duct: Type PVC-40 rigid non-metallic conduit, with RMC long radius sweep elbows.

B. Rigid Metal Conduit (RMC) type in accordance with Section 16131, “Conduits for Electrical Systems” with two coats of bitumastic paint or PVC coated where:

1. Direct buried conduit enters buildings, structures, and vaults (except manholes and handholes) with– not less than a 10-foot length of conduit.
2. Direct buried conduits run below floor slabs in slab-on-grade construction.
3. Stub-ups outdoors or through concrete slabs.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 02300 "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures.

3.4 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Engineer for resolution of conflicting requirements.

B. General Requirements:

1. Comply with installation requirements for conduits in Section 16131 “Conduits for Electrical Systems” and as supplemented herein.
2. Ductbank routing and manhole / handhole locations indicated on Drawings are diagrammatically depicted. Coordinate with other utilities, yard piping, yard structures and field conditions to determine required paths and depths at no additional cost to Owner.
3. Where conditions do not allow neat and consistent duct bank cross sections in accordance with Drawings due to existing underground conflicts, provide Engineer with proposed solution for approval that complies with minimum NEC installation cover requirements. For example, where the Drawings indicate direct buried PVC conduits are to be installed at a certain depth below finished grade, a concrete cap or concrete encasement may be

permitted to achieve an equivalent protection. Do not deviate from Drawing details without Engineer approval.

4. Reinforce ductbanks as indicated on Drawings. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Separate underground copper signal conduits (instrumentation and telecommunication) from power conduits by a minimum of 12 inches unless noted otherwise. Keep crossing of these conduits to a minimum; cross at 90 degree angles.
6. Plug conduit ends during and after installation to prevent water, mud, and debris from entering conduit.
7. After duct installation is complete and before any cables are pulled, remove obstructions using appropriately sized mandrel for conduits 2 inch and larger. Swab clean interior of all sized conduits. Refer to CLEANING Article.

C. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
3. Curves and Bends: Use long radius elbows, sweeps, and offsets for 2 inch and larger conduits.
4. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
5. Terminations at Manholes: Use end bells for PVC conduit and insulated throat grounding bushings with lay-in type lugs for RMC.
6. Building Wall Penetrations: Make transition from underground duct to RMC at least 10 feet outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to RMC type installed. Install RMC penetrations of building walls as specified in Section 16064 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
7. Underground-Line Warning Tape: Bury underground line specified in Section 16070 "Identification for Electrical Systems" above concrete-encased duct and direct buried duct banks as shown on detail Drawings. Align tape parallel to and within 3 inches of centerline of duct bank. Provide additional warning tape for each 12 inch increment of duct-bank width over nominal 18 inches. Space additional tapes 12 inches apart, horizontally across width of ducts.
8. Ground ducts and duct banks in accordance with Section 16056 "Grounding and Bonding for Electrical Systems."

D. Concrete-Encased Ducts and Duct Bank Special Techniques:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 02300 "Earthwork" for pipes 6 inches or less in nominal diameter.
2. Depth: Install so top of duct envelope is as shown on detail Drawing.
3. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

4. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch reinforcing-rod dowels extending minimum of 18 inches into concrete on both sides of joint near corners of envelope.

7. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03303 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
8. Concrete Color: Red. Dye color added to concrete during batching; or dye mixed with water and applied to top of ductbank with a sprayer while concrete is wet (prior to curing); or raked into the exposed top layer of concrete.

E. Direct-Buried Duct and Duct Bank Special Techniques:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earthwork" for preparation of trench bottoms for pipes less than 6 inch in nominal diameter.
2. Depth: Install top of duct as shown on detail Drawing.
3. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
4. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during backfill. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
5. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 02300 "Earthwork" for installation of backfill materials.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 16056 "Grounding and Bonding for Electrical Systems."

B. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 16063

This page left intentionally blank.

SECTION 16064 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND 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 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

B. Not all components specified in this Section are necessarily utilized on this project.

C. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product used on project.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics:

a. Material: Galvanized sheet steel.
b. Minimum Metal Thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness is to be 0.052 inch.
2) For sleeve cross-section rectangle perimeter not less than 50 inches or with one or more sides larger than 16 inches, thickness is to be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

B. Options:

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.6 POURABLE SEALANTS

A. Performance Criteria:

1. : Single-component, neutral-curing elastomeric sealants of grade indicated below.

a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.7 FOAM SEALANTS

A. Performance Criteria:

1. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion cannot damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07920 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

B. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

C. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 16064

SECTION 16070 - 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 SUMMARY

A. Section Includes: Identification products along with color and legend requirements.

B. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 16071 “Power System Studies” for arc flash study labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Note that not all products listed may be utilized on this project.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following where applicable:

1. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 feet above finished floor.

C. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed for conductors.

1. Color must be factory applied or field applied for sizes larger than 8 AWG.
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Neutral: White.

3. Colors for 480Y/277 V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: Gray.

4. Colors for DC Circuits:

    a. Positive: Red.
    b. Negative: Black.

5. Color for Equipment Grounding Conductors: Green.

6. Color for Equipment Grounding Conductor (600V rated): Green.

B. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

C. Warning labels and nameplates/signs must include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

D. Equipment Identification and Source Nameplate:

1. Color: White letters on a black field.
2. Material: See NAMEPLATES Article.
3. Equipment furnished under Divisions 16 and equipment control panels furnished under other Divisions must include equipment identification nameplates. Equipment includes, but is not limited to switchgear, switchboards, motor control centers, panelboards, transformers, disconnect switches, separately mounted motor controllers, transfer switches, control panels, and named enclosures or cabinets. Nameplate to match designation indicated on Drawings.
4. Power source must be identified at all applicable equipment. Nameplate may be separate from identification nameplate or information may be contained on one nameplate. For example, a local disconnect switch for a pump motor could have one nameplate reading “EFFLUENT PUMP NO. 4” for the identification nameplate and a second nameplate reading “FED FROM MCC-2”. Or a two-line nameplate combining the information for both identification and source.

E. Device Identification Labels:

1. Color: Black letters on a white field..
2. Material: Self-adhesive type, machine generated, 1/4 inch high letters.
3. Devices to be labeled with panel and branch circuit number include receptacles, wall switches, lighting fixtures, photocells, emergency lights, exit lights, instruments, etc. For example, a light switch powered from panelboard LP-2 and branch circuit 4 would have the label “LP-2/4” or “LP-2/CKT 4”.

2.3 NAMEPLATES

A. Material:

1. Engraved, engraved plastic (lamicoid).
2. Minimum size: Not less than 1/16 inch thick by 1-1/2 inch high by 1-1/2 inches wide.
3. Lettering: Upper case, 1/2 inch high minimum.

2.4 LABELS, BANDS, TUBES, AND SLEEVES

A. Self-Adhesive Wraparound Labels: Machine-printed, 3 mil thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive. Printed text is black, permanent, and waterproof.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.

B. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

C. Heat-Shrink Preprinted Tubes (Sleeve Type): Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 degrees F. Comply with UL 224. Printed text is black, permanent, and waterproof.

2.5 TAPES

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inches wide; compounded for outdoor use.

C. Underground-Line Warning Tape:

1. Tape:

   a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
   b. Printing on tape must be permanent and may not be damaged by burial operations.
   c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

   a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
   b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".
   c. Inscriptions for Orange Tapes: "CAUTION BURIED COMMUNICATION LINE BELOW".

3. Detectable Tape:

   a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
   b. Width: 6 inches.
   c. Overall Thickness: 5 mil.
   d. Foil Core Thickness: 0.35 mil.

2.6 TAGS

A. Metal Tags: Embossed, Type 316 stainless steel, 0.01 inch thick, punched for use with tie fastener. Secure with 0.048-inch diameter stainless steel band fastened with compression wire clamps

B. Nonmetallic Preprinted Tags: Polyester or Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.

2.7 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 degrees F in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 degrees F.
4. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Nameplates/Signs: Self-tapping, stainless steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF IDENTIFICATION PRODUCTS

A. Power-Circuit Conductor Identification, 1000 V or Less: For conductors at termination points and in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape if conductor is not factory colored to identify phase, neutral, and ground conductors. Use self-adhesive labels to identify circuit.

B. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

C. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with conductor designation.

D. Spare Conductors or Cables: Attach nonmetallic tags or self-adhesive labels to conductors and list source.

E. SCADA Systems, Communication Systems, Fire Alarm Systems or Other Auxiliary Electrical Systems Conductor Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with conductor designation.

F. Conduit Identification: For designated identification as indicated on Drawings provide self-adhesive labels.

G. Pull Boxes and Junction Boxes, 24 inches by 24 inches and Larger: For voltage identification provide self-adhesive warning labels.

H. Equipment Identification: For identification and source information provide nameplate(s) per COLOR AND LEGEND REQUIREMENTS Article.

I. Device Identification: For source and circuit information provide self-adhesive label per COLOR AND LEGEND REQUIREMENTS Article.

3.3 INSTALLATION

A. Install identification product in accordance with manufacturer’s instructions.

B. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Verify identity of item before installing identification products.

E. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

F. Apply identification devices to surfaces that require finish after completing finish work.

G. Apply wire markers so entire designation is clearly visible.

H. Install Arc Flash Labels in accordance with Section 16071 “Power System Studies”.

I. Identify the system voltage (e.g. 208/120 VOLTS, 480 VOLTS) at the covers of large pull boxes or junction boxes.

J. Install field device (instruments, receptacles, switches, etc.) labels.

K. Install equipment nameplates. Nameplate fastening requirements:

1. NEMA 1 and 12 Enclosures: Screw mounted using stainless steel screws.
2. Other Enclosure Types: Bonded using epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable.

L. Panelboard and Transformer Panel Assembly Identification:

1. Provide equipment identification nameplates as previously described.
2. Label branch circuit phase and neutral wires with associated pole number using self-adhesive labels or type written sleeve type labels.
3. Install typed as built circuit directory listing with unique load identification.

M. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 18 inch overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Install Tags. Fastening Requirements:

1. Secure metal tags using stainless steel ties.
2. Secure nonmetallic tags with UV-stabilized cable ties.

END OF SECTION 16070

This page left intentionally blank.

SECTION 16071 - POWER SYSTEM STUDIES

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. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 SUMMARY

A. Section includes a computer-based study for:

1. Short circuit report.
2. Protective device coordination report.
3. Motor starting report.
4. Arc flash report.

B. Study encompasses the power distribution system of the Fairfax Water, Reston Pump Station located at 11030 Sunrise Valley Drive, Reston VA.

C. Study includes the electric utility company’s protective devices, emergency generators, service entrance equipment and distribution to last serviceable disconnect. All power distribution to that point whether existing or new is included. Equipment included, but not limited to:

1. Substations and distribution.
2. Switchgear, switchboards, and panelboards.
3. Variable frequency controllers.
4. Disconnect switches.

D. Refer to Section 16010 "Supplemental Requirements for Electrical" for local electric utility contact information.

E. Obtain all data necessary to perform the study. Data included, but not limited to:

1. Up to date one-line diagrams.
2. Equipment data.
3. Cable sizes and lengths.
4. Existing protective device settings.

5. Electric utility information: available fault current, protective device equipment information and settings, X/R ratios, transformer impedances and ratings.

1.3 DEFINITIONS

A. Boundary, Arc Flash: When an arc flash hazard exists, an approach limit from an arc source at which the incident energy equals 1.2 cal/cm² (5 J/cm²).

B. Boundary, Limited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

C. Boundary, Restricted Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

E. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

F. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

G. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

H. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

I. Preliminary Short Circuit Report: Report that includes the maximum available utility fault current, proposed equipment, and existing equipment to determine if new equipment may be released for manufacturing and existing equipment is adequate for the calculated short circuit levels.

J. Protective Device: A device that senses when an abnormal condition or current flow exists and then removes the affected portion of the circuit from the system.

K. SCCR: Short-circuit current rating.

L. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

M. Single-Line Diagram: See "One-Line Diagram."

N. Supplier: The person, firm or corporation identified as such to provide the power system study and means the Supplier or its authorized agent. See also Power Systems Analysis Specialist.

O. VFD: Variable frequency drive. Interchangeable with variable frequency controller (VFC).

1.4 ACTION SUBMITTALS

A. Supplier qualifications per Quality Assurance paragraph. Submit prior to starting study. Include the following:

1. Brief description of each qualifying study.
2. Name of owner of installation on which study was performed with address, telephone number, and contact person.
3. Date of study.
4. Any other information indicating the firm's experiences and ability to perform the work and business status.

B. Preliminary Power System Study Report. Report must be approved prior to the Engineer shop drawing review and release for manufacture of major electrical equipment including but not limited to switchgear, switchboards, distribution panels, and motor control centers. Fault data from the utility must be included and not assumed or submittal will be rejected.

C. Final Power System Study Report. Report must be approved prior to energization of new major electrical equipment. Revise study as required for changes during construction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. If requested, Product Certificates: For power system study software, certifying compliance with IEEE 399, IEEE 1584 and NFPA 70E.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Final power system study updated with any changes made after equipment start-up.

B. Provide digital computer files with full read-write access of the complete power system model and library to the Owner.

1.7 QUALITY ASSURANCE

A. Perform Study using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Design computer program to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
2. Develop computer program under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
3. Complies with IEEE 399, IEEE 141, IEEE 242, IEEE 519, IEEE 1015, and IEEE 1584 as applicable to the project scope.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located and has regularly engaged in this electrical engineering study specialty for minimum of five years and has performed at least three projects of similar complexity to this project within the last three years. Perform all elements of the study under the direct supervision and control of this professional engineer.

F. Power System Study Certification: Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

1.8 POWER SYSTEM STUDY MEETINGS

A. Supplier's professional engineer responsible for the study to attend a meeting with the Engineer and Owner at the Owner's facility up to and including three times.

B. Purpose of the three meetings are:

1. Initial meeting discusses the study's scope and the Owner's operational and maintenance requirements prior to the preliminary study submittal.
2. Second meeting discusses the preliminary study and its recommendations. Based on this meeting, the Owner may request modifications to the studies' recommended protective settings to reduce the arc flash hazard or meet other operational objectives.
3. Third and final meeting presents the final study and its recommendations.

C. Provide a minimum of three-week notice to the Owner and Engineer in advance of all projected meeting dates.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Perform Power System Study using SKM System Analysis, Inc.: Power*Tools.

2.2 POWER SYSTEM STUDY REPORT GENERAL REQUIREMENTS

A. Except for one-line diagrams, standard 8 1/2-inch by 11-inch pages, with total pages numbered.

B. Electronic PDF format copy with electronic bookmarks for each section.

C. Signed and sealed by a professional engineer registered in the state in which the project is located.

D. Organized in the following order:

1. Executive Summary.
2. Short Circuit Analysis.
3. Short Circuit Computer Printout.
4. Protective Device Coordination.
5. Motor Starting.
6. Arc Flash Hazard Analysis.
7. Harmonic Analysis.
8. Utility Data.
9. Modeled One Line Diagrams.

E. Information on one-line diagrams, legible when printed at 11-inch x 17-inch. Show the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA), impedance, and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

F. Identifiers between the one-line diagram, short circuit study, coordination study, and arc flash study to be the same.

G. Include copies of correspondence with electric utility under utility data section of report. Correspondence to include names and contact information.

2.3 EXECUTIVE SUMMARY

A. Include summary of distribution system, information received from electric utility, major assumptions, adequacy of equipment to safely clear or close on any fault, identify problem areas and recommendations for resolving problem areas.

2.4 SHORT CIRCUIT

A. Comply with IEEE 399 and IEEE 551 (new 3002 series).

B. Include normal utility powered configuration, on-site generation configuration, and alternate modes of operation (i.e. alternate utility configuration, bus ties closed).

C. Include minimum and maximum possible fault conditions. Address three-phase bolted as well as ground fault conditions.

D. Consider the fault contribution of all motors operating during the maximum demand condition of the motors.

E. Calculate short-circuit momentary duties and interrupting duties based on an assumed bolted three-phase short circuit at each high and medium voltage switchgear bus and controller, low voltage switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard and other significant locations throughout the systems. Include the X/R ratios, asymmetry factors, KVA and symmetrical fault-current in the short circuit tabulations. Provide a ground fault current study for the same system areas. Include in tabulations fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault-currents.

F. Include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.

G. Identify available fault current at each bus and evaluate system elements including but not limited to equipment, protective devices, and cables.

H. Base current transformers' ratio and burden calculations on a 10 percent maximum ratio error per IEEE C57.13. Identify current transformers that will not allow the protective devices to operate within acceptable IEEE error margins and recommend corrective action.

I. List momentary, interrupting, and/or withstand rating of all key elements of the distribution system along with the maximum available fault current in tabular form and clearly indicate the adequacy of the element with PASS / FAIL designation.

J. Short Circuit Computer Printout:

1. Calculations shall be in sufficient detail for easy review.
2. Back up calculations shall become part of the final report.

2.5 PROTECTIVE DEVICE COORDINATION

A. Comply with IEEE 242 (new 3004 series).

B. Utilize results from the short circuit study and balance the competing objectives of protection and continuity of service for the system specified, considering the basic factors of sensitivity, selectivity and speed. Include all system protective devices in the coordination analysis, not just

overcurrent protective devices. This includes, but is not limited to under and over voltage protective relays, frequency relays, differential relays and reverse power relays.

C. Show graphic indication of coordination between protective devices in the form of full color time-current coordination (TCC) plots with each protective device curve in a unique color for easy review.

D. Provide separate TCC plots for each mode of operation. Provide separate TCC plots for "normal" and "stand by" operation. Show maximum fault values in each case. Both power sources shown on one plot is unacceptable.

E. Provide separate TCC for phase over-current and ground fault.

F. Show no more than six devices on one TCC. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots to provide cross-reference. Designate each TCC with a unique identifier and include each TCC identifier and descriptive title in the study's table of contents.

G. Include in each TCC the following as applicable:

1. TCC name and description.
2. One-line diagram.
3. Identifiers on one-line diagram and curves.
4. Significant motor starting characteristics.
5. Appropriate NEC protection points.
6. Appropriate ANSI/IEEE protection points.
7. Magnetizing inrush points of transformers.
8. Transformer damage curves.
9. Complete operating bands for low voltage circuit breaker trip devices and fuses.
10. Relay coil taps, time-dial settings and pickup settings.
11. Significant symmetrical and asymmetrical fault currents.
12. Power cable withstand curves.
13. Generator short circuit decrement and thermal limit curves.

H. Terminate device characteristic curve on TCC at a point reflecting the maximum symmetrical or asymmetrical fault current to which that device is exposed, based on the short circuit study.

I. Select each primary protective device for a delta-to-wye-connected transformer so the characteristic or operating band is within the transformer parameters; where feasible, include a parameter equivalent to 58 percent of the ANSI C37.91 withstand curve to afford protection for secondary line-to-ground faults.

J. Separate low voltage power circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults.

K. Separate protective relays by a 0.3-second time margin for the maximum 3 phase fault conditions to assure proper selectivity.

L. Optimize settings for breakers and relays to provide the most effective protection practicable for all modes and power sources.

M. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and/or power distribution panelboard. Include all adjustable setting ground fault protective devices.

N. Provide tabulations of recommended settings for all protective devices. Where devices are existing, highlight any changes from the existing setting to the proposed recommended setting.

O. Provide all information required to program/set multifunction solid state relays.

2.6 MOTOR STARTING

A. Comply with IEEE 141 (new IEEE 3001 series) for recommended light flicker limits and IEEE 3002.7 for motor starting studies.

B. Provide motor starting study for all large electric drives (100 horsepower and larger). Include all operating modes.

C. Identify any concerns about voltage drop or power inrush limitations due to the starting of motors.

2.7 ARC FLASH HAZARD

A. Comply with IEEE 1584, NFPA 70, and NFPA 70E as applicable.

B. Utilize short circuit and protective device coordination results to provide arc flash hazard analysis. Perform calculations in accordance with IEEE 1584.

C. Calculate the incident energy levels at each faulted bus for each mode of operation and for both maximum and minimum fault currents.

D. Include calculations at line side and load side of main breakers, where applicable.

E. Provide tabular report for all modes and conditions and include “worst case” summary. Use the “worst case” to generate the arc flash labels. Include:

1. Fault location.
2. Arcing fault magnitude.
3. Protective device clearing time.
4. Duration of the arc.
5. Arc flash boundary.
6. Working distance.
7. Incident energy.
8. Electrode configuration.

F. If the arc flash incident energy at any location is over 40 cal/cm2, the contractor, the manufacturer, and the engineer shall provide solution (before shop drawing approval) to reduce the energy levels or to mitigate the hazard during the operations and maintenance, by lowering the energy to a safe level, or keep workers at a safe distance

G. Arc Flash Labels:

1. Machine printed, 4-inches x 4-inches (nominal), thermal transfer, high adhesion polyester.
2. Provide UV resistant laminate for outdoor labels.

H. Arc Flash Label Information:

1. Equipment name.
2. Identifier LINE or LOAD where equipment has potential different energy levels.
3. Arc flash hazard information: arc flash boundary and incident energy in cal/cm^2.
4. Shock hazard information: limited approach and restricted approach boundaries.
5. Personal Protective Equipment (PPE) requirements.
6. Study Supplier, project number, and date.

I. Provide arc flash label sample with preliminary report.

J. Do not be print the labels until equipment is energized and protective devices set according to the approved final protective device coordination study.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the power system study.

C. Field data gathering for existing systems shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

D. Data included, but are not limited to, the following:

1. Product data for overcurrent protective devices and existing settings.
2. Electrical power utility information. Information required may include:

a. Available minimum and maximum three-phase fault current and X/R ratio.
b. Available minimum and maximum single-line-to-ground fault current and X/R ratio.
c. Service transformer voltage, kVA, and impedance ratings, winding configuration, and grounding method.

d. Upstream protective device data.

3. Power sources and ties.
4. For switchgear, switchboards, panelboards, and motor control centers, ampacity and SCCR in amperes RMS symmetrical.
5. For transformers, kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
6. For reactors, manufacturer and model designation, voltage rating, and impedance.
7. For circuit breakers, trip units, and fuses, manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
8. For generators, short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. For busways, manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. For motors, horsepower and NEMA MG 1 code letter designation.
11. Conductor sizes, lengths, number, conductor material, shield parameters for medium voltage cable, and conduit material (magnetic or nonmagnetic).
12. For relays, manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
13. For transfer switches, withstand and closing ratings (WCR) with time duration.
14. Derating factors.

3.2 FIELD QUALITY CONTROL

A. Do all testing and adjustment prior to the energization of new equipment.

B. Test existing adjustable protective devices in accordance with NETA MTS.

C. Test new adjustable protective devices in accordance with NETA ATS.

D. Adjust existing and new protective devices according to approved coordination study.

E. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

F. After successful testing and adjustment, install calibration sticker with Field Adjusting Agency name, employee initials, and date of calibration at each relay or protective device.

G. After energization, minor adjustments to settings may be required to commission the equipment.

H. Submit field report and list any changes made during field adjustment or commissioning for update for record submittal of study.

3.3 ARC FLASH LABELING

A. After the field adjustment of relays and protective devices, apply arc flash study labels.

B. Apply arc flash labels on the front covers of the following equipment:

1. Substations and distribution transformers.
2. Medium voltage switches.
3. Switchgear, switchboards, and panelboards.
4. Motor control centers.
5. Variable frequency controllers.
6. Disconnect switches.
7. Transfer switches.
8. 480V control panels.

C. Apply arc-flash labels at each section for large equipment such as switchgear and motor control centers.

D. Install LINE and LOAD arc-flash labels as applicable.

E. Remove any previous arc flash study labels as applicable and install new labels under the direction of the Power System Analysis Specialist.

END OF SECTION 16071

This page left intentionally blank.

SECTION 16080 - COMMISSIONING OF 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 SUMMARY

A. Section includes procurement of the services of an Electrical Testing Firm Supplier (ETFS) to provide all materials, equipment, labor, and services required to achieve a fully commissioned electrical system.

B. The intent of the Section is to:

1. Provide electrical system construction planning.
2. Provide summary qualifications of the testing firm.
3. Summarize division of responsibility for electrical commissioning.
4. Define additional testing, inspections, and adjustments.

C. The following Division 16 Sections include testing and/or settings requirements:

1. Section 16052 “Low-Voltage Electrical Power Conductors and Cables”.
2. Section 16056 “Grounding and Bonding for Electrical Systems”.
3. Section 16071 "Power System Studies”.
4. Section 16223 “ Low Voltage Distribution Transformers”
5. Section 16230 “Low-Voltage Switchgear”
6. Section 16246 “ Panelboards”
7. Section 16293 “ Soft Start Motor Controllers”
8. Section 16296 “Variable- Frequency Motor Controllers”

D. Other Divisions include electrical testing requirements for equipment with electrical components. These include:

1. Automation Equipment – Division 13.
2. Process Mechanical Equipment and Associated Motors – Divisions 15.

E. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 DEFINITIONS

A. Low Voltage: 600 V and below.

B. Maintenance of Plant Operations (MOPO): A construction plan which prevents or limits process disruptions during construction.

C. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 MEETINGS

A. Hold meeting at Owner's designated location. Attendance to include representatives of the Owner, Engineer, and Contractor (general, electrical, ETFS).

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For ETFS and personnel intended for the project.

B. Field Quality-Control Reports:

1. Table of contents / Executive summary.
2. Test procedures and equipment used, include calibration dates.
3. Test results that comply with requirements.
4. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
5. Typed test forms, no handwritten entries.

C. Certification that all adjustable circuit breakers have been adjusted to the power system study final approved setting.

D. Certification that arc flash labels that correspond to the final approved power system study have been applied.

1.6 ACTION SUBMITTALS

A. Switchgear Test Plan.

1. Submit, no later than 30 calendar days prior to first equipment start-up, a plan for operational checks.

B. Power Monitoring / SCADA Verification Plan.

1. Submit, no later than 30 calendar days prior to substantial completion, the list of SCADA points to confirm. Confirmation of actual data (i.e. the breaker is open/closed; amps / volts / kVA readings are correct) is to be done when load is running.

1.7 QUALITY ASSURANCE

A. ETFS Qualifications: Corporately and financially independent testing organization, to provide unbiased test results, and is professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.. The ETFS, may be but is not required to be the same firm as the power system study supplier.

B. ETFS Electrical Technician Qualifications: NETA or ETT Certified Technician Level III or NICET Electrical Power Testing Level II Certification.

1.8 DIVISION OF RESPONSIBILITY

A. Electrical Contractor Responsibilities Include:

1. Routine insulation-resistance, continuity, and rotation checks prior to and in addition to manufacturer or ETFS testing.
2. Transformer voltage checks and adjustment of taps.
3. Phasing checks across tie breakers and transfer switches.
4. Motor rotation and ampacity checks, overload settings, field test reports.
5. Provide suitable and stable source of electrical power required for testing.
6. Coordination and scheduling with Owner, Engineer, Equipment Manufacturers/Suppliers, and ETFS.
7. Obtain the power system study. Engineer must review and approve study prior to placing any new equipment in service.

B. Equipment Manufacturer Responsibilities:

1. Installation checks and testing as listed per individual Section.

C. ETFS Responsibilities:

1. Installation checks and testing as listed per individual Section.
2. Switchboard commissioning.
3. Verification of correct power monitoring on the SCADA system.
4. Setting and adjustments to protective devices and adjustable circuit breakers per the final approved power system study.
5. Installation of arc flash labels.
6. Final infrared testing as listed per individual Section of all new, relocated, or re-terminated equipment.

D. Additional Testing, Inspections, and Adjustments:

1. Infrared testing of non-modified equipment is not included / required.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Field testing and commissioning is intended to follow the latest revisions of NETA Standard ATS, ECS, and MTS as applicable unless otherwise modified in these Sections.

B. Site standard phase rotation is clockwise. That is when phases A, B, C are connected to terminals 1, 2, 3 the phase rotation will be clockwise. If phase rotation must be corrected, it should be done at the end device, i.e. the motor.

C. Where two in-house potential sources are present and may be connected, regardless of the safety interlocks provided, testing to verify correct phasing is required. Without checking this, one source may have clockwise rotation with a 123-ABC and the second source may have a clockwise rotation with a 123-BCA installation. A three-phase short would result if safety interlocks fail and these two sources are connected inadvertently. Hot phase testing is required at all two source locations.

3.2 FIELD QUALITY CONTROL

A. Verify electrical equipment and systems have been tested in compliance with Contract Documents.

B. Provide reports per Paragraph 1.5 B.

END OF SECTION 16080

SECTION 16090 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes equipment and systems used to monitor and control electrical consumption:

1. Power meters.
2. Monitoring and control of power distribution equipment.
3. System operator interfaces.
4. Raceways and boxes.
5. Wires and cables.
6. Identification.

B. Related Requirements:

1.3 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. LAN: Local area network.

H. L-G: Line to ground.

I. L-L: Line to line.

J. L-N: Line to neutral.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

L. Modbus TCP/IP: An open protocol for exchange of process data.

M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

N. N-G: Neutral to ground.

O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

P. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

Q. TCP/IP: Transport control protocol/Internet.

R. UPS: Uninterruptible power supply; used both in singular and plural context.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

    a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

        1) Location of the meters and gateways, and routing of the connecting wiring.
        2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.

5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

    a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
    b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    c. As-built versions of submittal Product Data.
    d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
    e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
    f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    g. Engineering, installation, and maintenance manuals that explain how to do the following:

        1) Design and install new points, panels, and other hardware.
        2) Perform preventive maintenance and calibration.
        3) Debug hardware problems.
        4) Repair or replace hardware.

    h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
    i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
    j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
    k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
    l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
    m. Owner training materials.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1. Electrical meters that monitor, control, and connect to the data transmission network.
2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 POWER METERS

A. Manufacturers: Subject to compliance with requirements, provide products manufactured by submitted switchgear manufacture:

B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of minus 13 to 158 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

E. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.

F. Data Link:

1. RS-485 Modbus RTU protocol.

a. Provide for firmware and software updates through the communications port.

G. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.

2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:

    a. All meters, including those listed under the following:

        1) Measurements.
        2) THD.
        3) Energy.
        4) Demand.
        5) Minimum and maximum values.
        6) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters:

1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.

    a. Voltage: L-L each phase, L-N each phase, and three-phase average.
    b. Current: Each phase, three-phase average, and neutral.
    c. Unbalanced current, L-L V ac and L-N V ac.
    d. Active Power (+/- kW): Each phase and three-phase total.
    e. Reactive Power (+/- kVAR): Each phase and three-phase total.
    f. Apparent Power (+/- kVA): Each phase and three-phase total.
    g. Displacement Power Factor: Each phase and three-phase total.
    h. Distortion Power Factor: Each phase and three-phase total.
    i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.

    a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
    b. Current THD: Each phase and three-phase average.
    c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

    a. Active kWh.
    b. Reactive kVARh.
    c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

    a. Three-phase average current.
    b. Three-phase total active power (kW).
    c. Reactive power (kVAR).
    d. Apparent power (kVA).

5. Minimum and Maximum Values:

a. L-L and L-N voltages.
b. Current in each phase.
c. Power factor.
d. Active power total.
e. Reactive power total.
f. Apparent power total.
g. THD L-L and L-N voltages.
h. THD current in each phase.
i. Frequency.

J. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    b. Fixed block that calculates demand at end of the interval.
    c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

K. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time rms measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

L. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:

1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

M. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.

2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

N. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

O. Capacities and Characteristics:

1. Power Supply: .480-V ac, +/- 5 percent, 60 Hz;
2. Circuit Connections:

a. Voltage: Measurements auto ranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:

    a. User configurable, with secure password-protected login process.
    b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
    c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.
    d. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across all styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:

    a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
    b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
    c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
    d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
    e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
    f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
    g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.5 RACEWAYS AND BOXES

A. Comply with requirements in Section 16131 "Conduits for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

2.6 WIRES AND CABLES

A. Electrical Power Wiring:

1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring:

1. Optical-Fiber Cable: Multimode, 50/125-micrometer OM3, six-fiber, nonconductive, tight-buffer, optical-fiber cable, with aqua jacket.
2. Balanced Twisted Pair Cable: 100-ohm, four-pair Category 6.
3. RS-485 Cable: Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
4. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

    a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
    c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

2.7 SURGE PROTECTION DEVICES

A. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. L-N: 1200 V for 480Y/277 V.
2. L-G: 1200 V for 480Y/277 V.
3. N-G: 1200 V for 480Y/277 V.
4. L-L: 2000 V for 480Y/277 V.

E. SCCR: Equal or exceed 200 kA.

F. Nominal Rating: 10 kA.

G. Indoor Enclosures: NEMA 250, Type 12**.**

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

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

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Wiring and Cabling Installation:

1. Comply with Section 16052 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

E. Raceways Installation:

1. Comply with code requirements for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

F. Identification Installation:

1. Comply with Section 16052 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

3.3 GROUNDING

A. For data communication wiring, comply with NECA/BICSI 568.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Power Monitoring and Control System Tests.

    a. Test Analog Signals:

        1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
        2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
        3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

    b. Test Digital Signals:

        1) Check digital signals using a jumper wire.
        2) Check digital signals using an ohmmeter to test for contact making or breaking.

    c. I/O Control Loop Tests:

        1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
        2) Test every I/O point throughout its full operating range.
        3) Test every control loop to verify that operation is stable and accurate.

4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.
7) Operate each analog point at the following:

a) Upper quarter of range.
b) Lower quarter of range.
c) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

B. Wiring and cabling will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 FINAL REVIEW

A. Submit written request to Engineer and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review shall include a demonstration to parties participating in final review.

3.6 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.

B. Extent of Training:

1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

    a. Provide no fewer than two days of training total.

C. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide Owner with a PDF copy of all hard-copy materials.

D. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have no fewer than 2 years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.

E. Training Outline: Submit training outline for Owner review at least 10 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.

F. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

G. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

3.8 At Completion of Training:

A. Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

B. Demonstration shall include, but not be limited to, the following:

1. Accuracy and calibration of I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Trends, summaries, logs, and reports set-up for Project.
3. Software's ability to edit control programs off-line.
4. Data entry to show Project-specific customizing capability including parameter changes.
5. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
6. Execution of digital and analog commands in graphic mode.
7. Spreadsheet and curve plot software and its integration with database.
8. Online user guide and help functions.
9. For Each Meter:

    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

END OF SECTION 16090

SECTION 16131 - CONDUITS 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 SUMMARY

A. Section Includes: Conduits and fittings.

B. Products Installed, but Not Furnished, under This Section:

1. Section 16070 "Identification for Electrical Systems" for conduit identification labels.

C. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 16059 “Boxes and Covers for Electrical Systems” for conduit bodies, outlet and device boxes, pull boxes, and junction boxes.
4. Section 16057 “Hangers and Supports for Electrical Systems” for channel support systems and miscellaneous mounting components.
5. Section 16063 “Underground Ducts and Raceways for Electrical Systems” for underground construction requirements.

1.3 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.4 ACTION SUBMITTALS

A. Product Data: Manufacturer’s cut sheet for each type of product used on project. Note some conduit types listed may not be used on the project. Refer to the Conduit Selection Table in

PART 3. If multiple manufacturers of a given type of conduit or fittings are proposed, submit those cut sheets rather than stating “or equal”.

B. Conduit Layouts: For Division 16 conduits installed underground and concealed within buildings and structures. Show equipment, boxes, handholes, manholes, routing, materials, and sizing. Provide layouts at an appropriate scale for clarity. Submission of separate drawings for power, lighting and control for one area is acceptable. Provide schedule for easy cross check. Utilize Contract Drawing computer model file and uniquely layer the different conduit systems, i.e. medium voltage, low voltage, control, fiber, etc.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 TYPE ERMC-S DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Description: Galvanized rigid steel conduit, elbows, couplings, and nipples, with a hot-dipped galvanized finish inside and out and per NEC Article 344.

B. Listing Criteria:

1. UL DYIX – Rigid Ferrous Metal Conduit, including UL 6.
2. UL DYJC – Rigid Ferrous Metal Conduit with Polyvinyl Chloride Coating, including UL 6.

C. Long radius elbows as indicated in Section 16063 “Underground Ducts and Raceways for Electrical Systems”.

D. PVC Coated Type: 40 mil PVC on exterior and 2 mil urethane on interior. (ERMC-S-PVC).

2.3 TYPE LFMC DUCT RACEWAYS

A. Description: Liquidtight Flexible Metal Conduit, Type UA, per NEC Article 350.

B. Listing Criteria: UL DXHR – Liquid-tight Flexible Metal Conduit, including UL 360.

C. Material: Steel (LFMC-S).

D. Manufacturer: Sealtite®, Type UA, as manufactured by Anaconda, continuously interlocked flexible steel conduit with sunlight and chemical resistant PVC jacket.

2.4 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Description: Rigid Polyvinyl Chloride Conduit, sunlight resistant, rated for use with 90 degree C conductors in exposed and direct or concrete encased applications, per NEC Article 352.

B. Listing Criteria: UL DZYR – Rigid Nonmetallic PVC Conduit, including UL 651.

C. Type: Schedule 40 and Schedule 80.

2.5 FITTINGS FOR CONDUIT AND TUBING

A. General: Listed and labeled for type of conduit, location, and use.

1. ERMC-S: Use cast malleable iron fittings.

B. Listing Criteria as Applicable:

1. UL 514B – Conduit, Tubing, and Cable Fittings.
2. UL DWTT – Conduit Fittings.
3. UL DXAS – Liquid-tight Flexible Metal Conduit Assemblies.

C. Refer to Section 16059 “Boxes and Covers for Electrical Systems” for conduit bodies such as LB’s, T’s, and C’s.

D. Metal Fittings:

1. RMC Fittings: Threaded type. Threadless fittings and split couplings are not permitted.
2. Fittings for PVC Coated Conduit: Minimum 40 mil thick PVC coating, with overlapping sleeves of one pipe diameter in length to protect threaded joints.
3. LFMC Fittings: Three-piece screw in type, malleable iron.
4. Expansion Fittings: Include flexible external bonding jumper.
5. Grounding and Bonding Hubs, Bushings, and Hardware:

    a. Grounding Hub: Meyers type.
    b. Locknuts: Cast steel or aluminum.
    c. Bushings: Insulated throat with lay-in type lugs.

E. Nonmetallic Fittings:

1. PVC Fittings: Comply with NEMA TC 3 and match conduit material.

F. Specialty Fittings:

1. Defection/Expansion Fitting: OZ-Gedney Type DX or equal.
2. Expansion Coupling: Crouse-Hinds Type XJG with bonding jumper or equal.
3. Conduit Sealing Bushings: Refer to Section 16064 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling”.

2.6 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT.

A. Description: Cold galvanizing compound, 95 percent zinc rich paint.

B. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

2.7 SOLVENT CEMENTS

A. Description: Solvent cement to join Type PVC duct raceways and fittings.

B. Listing Criteria: UL CCN DWTT; including UL 514B.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Refer to Appendix Table 16131-1 for conduit application requirements.

B. Minimum Raceway Size: ¾ inch trade size.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following as applicable:

1. Relevant Article of NFPA 70.
2. NECA NEIS 101 – Standard for Installing Steel Conduits.
3. NECA NEIS 102 – Standard for Installing Aluminum Rigid Metal Conduit.
4. NECA NEIS 111 – Standard for Installing Nonmetallic Raceways.
5. NEMA FB 2.10 – Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing.
6. NEMA FB 2.20 – Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable.
7. NEMA FB 2.40 – Installation Guidelines for Expansion and Expansion/Deflection Fittings.
8. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
9. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

a. Complete duct raceway installation before starting conductor installation.

b. Underground Installations: Refer to additional requirements in Section 16063 “Underground Ducts and Raceways for Electrical Systems”.
c. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 feet above finished floor.
d. Coordinate stub-up locations with approved shop drawings for equipment to position stub-up directly below appropriate section of motor control center, switchboard, or switchgear.
e. Provide a 4 inch thick concrete housekeeping pad at slab and grade penetrations. Provide a 45 degree, 3/4 inch chamfer at exposed edges.
f. Maximum continuous conduit run: 300 feet. Reduce distance by 75 feet for each 90-degree elbow.
g. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
h. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
i. Support conduit within 12 inches of enclosures to which attached.
j. Drainage: Arrange conduit system to allow liquids such as water, condensation, etc. to drain away from equipment served. If conduit drainage is not possible, plug conduits using conduit seals.
k. Moisture Control: Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways using “Duxseal” or seal fitting at the following points:

    1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    2) Where an underground service duct raceway enters a building or structure.
    3) Conduit extending from interior to exterior of building.
    4) Conduit extending into pressurized duct raceway and equipment.
    5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
    6) Where otherwise required by NFPA 70.

l. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
m. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
n. Keep duct raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
o. Cut conduit perpendicular to the length. For conduits trade size 2 and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
p. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use. Use threaded cap.

q. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
r. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to trade size 1-1/4 and insulated throat metal bushings on trade size 1-1/2 and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits. Install Meyers grounding type hubs when conduits terminate at NEMA 3R, 4, and 4X gasketed enclosures.

2. Protect metallic finish conduit installed in contact with concrete or below grade with two coats of bitumastic paint, heat shrink tubing, or approved equivalent. Provide protection from 12 inches below bottom of concrete to not less than 6 inches above surface of concrete.
3. Rigid Metal Conduit (Type ERMC):

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
b. The use of running threads is prohibited. Where such threads are necessary, use a three piece union.

4. PVC Coated Rigid Metal Conduit (Type ERMC-S-PVC):

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC-coated ERMC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on PVC-coated ERMC duct raceway.
c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Flexible Conduit Connections (Types FMC, LFMC, and LFNC):

a. Provide a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
b. Include adequate slack to allow for thermal expansion and mechanical vibration.
c. Orient outdoor flexible connections to provide drip loop to avoid accumulation of water at equipment connection points.

6. Non-Metallic Conduit (Type PVC):

a. Do not install Type PVC conduit where ambient temperature exceeds 122 degrees F. Conductor ratings must be limited to 75 degrees C except where installed in a trench outside buildings with concrete encasement, where 90 degrees C conductors are permitted.

b. Comply with manufacturer's published instructions for solvent welding and fittings.

7. Duct Raceways Embedded in Slabs:

a. Comply with spacing requirements as noted on Structural Drawings.
b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
c. Arrange duct raceways to ensure that each is surrounded by minimum of 1 inch of concrete without voids.

8. Stub-ups at Slabs: Arrange stub-ups so curved portions of bends are not visible above finished slab.
9. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.

10. Duct Fittings: Use only fittings listed for use with each type of tubing or conduit and in accordance with specific fittings listed under PART 2.

a. ERMC-S-PVC: Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

11. Expansion-Joint Fittings: Install where necessary to compensate for thermal expansion and contraction and wherever conduits cross building or structure expansion joints.
12. Identification: Install identification tags at conduits in accordance with Section 260553 “Identification for Electrical Systems”.

D. Interfaces with Other Work:

1. Coordinate installation with other trades in advance of installation.
2. Restore walls, floor, and roof to original condition such as watertight, fire rating, smooth and/or painted finish after duct raceway penetration.
3. Coordinate with Section 16057 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.4 APPENDICES

A. Table 16131-1: Conduit Selection Guidelines

Table 16131-1 Conduit Selection Guidelines	
Raceway Type	Location / Application
ERMC-S	Indoor and outdoor applications, except where other types are listed. Exposed, non-corrosive areas. Concealed, non-corrosive areas. Under slabs in slab on grade construction / stub-ups. When installed underground or in contact with concrete, paint with two coats of bitumastic paint or use ERMC-S-PVC.
ERMC-S-PVC	Allowed for use in lieu of painting ERMC-S with two coats of bitumastic paint
LFMC	Flexible connections used in conjunction with ERMC types.
PVC-40	Concrete encased duct banks. Embedded in concrete slabs or structures. Underground elbows are to be ERMC type.
PVC-80	Direct buried. Areas designated as corrosive. Protection of grounding electrode conductors. Protection of lightning conductors. Underground elbows are to be ERMC type.

END OF SECTION 16131

SECTION 16223 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

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. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

C. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with KVA as noted on the Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

C. Coils: Continuous windings except for taps.

1. Coil Material: Copper.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.

1. NEMA 250, Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
2. Wiring Compartment: Sized for conduit entry and wiring installation.

F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

G. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

H. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

I. Wall Brackets: Manufacturer's standard brackets.

J. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.

2.4 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 16070 "Identification for Electrical Systems."

B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 16070 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. High-voltage to ground.
    b. Low-voltage to ground.
    c. High-voltage to low-voltage.

9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 16056 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 25 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 03303 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 16057 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 16056 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 16052 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, and grounding.
    c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    d. Verify the unit is clean.
    e. Perform specific inspections and mechanical tests recommended by manufacturer.
    f. Verify that as-left tap connections are as specified.
    g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

    a. Measure resistance at each winding, tap, and bolted connection.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 16223

This page left intentionally blank.

SECTION 16243 – SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Requirements

1. Section 16010 “Supplemental Requirements for Electrical”.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company’s metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Delegated Design Submittal:

1. For arc-flash hazard analysis.
2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01782 “Operation and Maintenance Data,” include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 FACTORY SHOP AND FUNCTIONAL DEMONSTRATION TESTS

A. Prior to shipment of equipment, perform production tests on complete switchboard assembly in accordance with NEMA PB 2. Provide at least 2 months in advance for review by the Engineer and the Owner, all details of the proposed testing, including arrangements, test instruments, calibration and procedures to be used to verify controls and alarms.

B. The interconnecting control and signal wiring for the Switchboard and automatic transfer controller shall be wired and operational to demonstrate the systems integrated functionality as specified herein. All operator interface units (OITs) and PLCs shall be programmed at the factory and shall be fully functional and witnessed by the Engineer and the Owner as a complete system at the manufacturer's facility prior to shipment. Provide two weeks' notice to the Engineer and the Owner prior to the factory tests. Should the tests fail during the first factory visit, the manufacturer of the switchboard shall pay for all travel from the Engineer's and the Owner's offices, local transportation, lodging and meals for two persons for the second witness test, including the labor expenses for two persons at a rate of $1200 each per day.

C. Provide the Engineer with two certified copies of test data and reports.

D. Test results shall indicate that equipment meets standards specified before shipment can be made.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.10 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 104 deg F.
    b. Altitude: Not exceeding 6600 feet

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than 10 working days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Construction Manager's and Owner's written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Square D; Schneider Electric USA.
4. Siemens.
5. Or Approved Equal.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Drawout mounted.
2. Branch Devices: Drawout mounted.
3. Sections front and rear aligned.

I. Nominal System Voltage: 480Y/277 V.

J. Main-Bus Continuous: 1200 A.

K. Indoor Enclosures: Steel, NEMA 250, Type 1.

L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

M. Barriers: Between adjacent switchboard sections.

N. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

O. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

P. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Q. Buses and Connections: Three-phase, four-wire, unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, tin-plated.
3. Tin-plated Copper feeder circuit-breaker line connections.
4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

7. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

R. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

A. SPDs: Comply with UL 1449, Type 2.

B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.

C. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. SCCR: Equal or exceed 200 kA.

G. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Drawout circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Time adjustments for long- and short-time pickup.
    c. Ground-fault pickup level, time delay, and I squared t response.

4. Remote trip indication and control.
5. Control Voltage: 120-V ac.

B. Fuses are specified in Section 16283 “Fuses.”

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: ANSI Standard C57.13; 120 V, 60 Hz, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: ANSI C57.13; 5 A, 60 Hz, secondary; wound type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Refer to Section 16090 “Electrical Power Monitoring and Control” for additional requirements.

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

    a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    d. Megawatts: Plus or minus 1 percent.
    e. Megavars: Plus or minus 1 percent.
    f. Power Factor: Plus or minus 1 percent.
    g. Frequency: Plus or minus 0.1 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
4. Appropriate multiplier tag.

C. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month’s ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Main Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 POWER TRANSFER CONFIGURATIONS

A. Factory-installed and -tested controls of circuit breakers to accomplish automatic transfer controls for switchboard having two power sources.

B. Components, including UPS, PLC, and OIT, for power transfer controls shall be in accordance with Division 13 requirements.

C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

D. Control Wiring:

1. Factory installed, complete with bundling, lacing, and protection.
2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
3. Install plugs in control wiring at shipping splits.

E. Two-Breaker Transfer Control:

1. Two-breaker transfer control shall provide for a switchboard assembly with a common load bus and two normally energized low-voltage power sources, designated "normal" and "standby," connected to the load bus. Circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage sensing transformers.

2. In addition to performing the below described controls, the microprocessor will serve as a data concentrator for monitoring all connected components. Refer to the Electrical Drawings. The microprocessor shall be capable of native communication using the Modbus TCP protocol.

3. Provide an Operator Interface Terminal (OIT) to display status and alarms of connected components. OIT will communicate directly with the microprocessor using the Modbus TCP protocol over a direct ethernet connection.
4. In automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
5. Portable Generator Connection:
    a. Generator Disconnect Switch in the OFF position:
        1) Generator Disconnect Switch auxiliary contact will open to send a signal to the Microprocessor that the portable generator is not currently connected and inhibit an auto start signal from the Microprocessor Automatic Transfer Controller within the switchboard.
    b. Generator Disconnect Switch in the ON position:
        1) Automatic transfer from Utility to the portable generator and vice versa shall be as specified below.
6. Sequence of Operation:
    a. “Manual-Off-Auto” Selector Switch in Auto mode, and Generator Disconnect Switch in the ON position:

        1) Default operation shall be with the Main ‘B’ circuit breaker closed; and Main ‘A’ circuit breaker opened.

2) On detection of an undervoltage to the line side of the Main ‘B’ circuit breaker and after a field-adjustable time delay, Main ‘B’ circuit breaker shall open and a generator start signal shall be sent out. Once the generator is up to speed and rated voltage, Main ‘A’ circuit breaker shall close, restoring power to the failed bus.

3) The Automatic Transfer Controller shall send a signal to SCADA when running on generator power, to limit the number of pumps that can be run.

4) On restoration of normal power to the line side of the previously opened Main ‘B’ circuit breaker and after a field-adjustable time delay, the Automatic Transfer Controller shall send a signal to SCADA to indicate utility power is available to allow for a controlled shutdown of the running pumps. Main ‘A’ circuit breaker shall open then Main ‘B’ circuit breaker shall close. After a field-adjustable time delay and additional field-adjustable generator cool-down period, the automatic transfer controller shall send a signal for the generator to shut down. The automatic transfer controller shall include hardwired interlocks to prevent the utility and generator sources from running in parallel.

b. “Manual-Off-Auto” Selector Switch in Manual mode, and Generator Disconnect Switch in the ON position:

1) When the Start pushbutton is pressed, and after a configurable time delay, the Automatic Transfer Controller shall send a signal to the generator controller to start the generator.
2) After the generator has started and reached the correct frequency, the Automatic Transfer Controller shall open Main ‘B’ circuit breaker and then close Main ‘A’ circuit breaker to supply power to the switchboard.
3) The Automatic Transfer Controller shall send a signal to SCADA when running on generator power, to limit the number of pumps that can be run.
4) When the Stop pushbutton is pressed, the Automatic Transfer Controller shall send a signal to SCADA to indicate utility power is available to allow for a controlled shutdown of the running pumps. After a configurable time delay, the Automatic Transfer Controller shall open Main ‘A’ circuit breaker and then close Main ‘B’ circuit breaker. The Automatic Transfer Controller shall include hardwired interlocks to prevent the utility and generator sources from running in parallel.

7. Generator Exercising/Testing mode:

a. Generator shall be exercised for programmable exercise schedule, or when Test Mode is selected on the OIT of the Automatic Transfer Controller. The OIT shall permit the user to select between a test With Load Transfer or Without Load Transfer.

b. With Load Transfer: When the user initiates the test from the OIT, the Switchboard shall simulate a loss of Utility.
1) Main ‘B’ circuit breaker shall open and a generator start signal shall be sent out. Once the generator is up to speed and rated voltage, Main ‘A’ circuit breaker shall close, restoring power to the failed bus.

2) After exercising/test duration is complete, generator shall enter cooldown mode, Main 'A' circuit breaker shall open and the Main 'B' circuit breaker shall close.

c. Without Load Transfer: When the user initiates the test from the OIT, the Switchboard shall start generator without simulating loss of Utility.
   1) A generator start signal shall be sent out.
   2) After exercising/test duration is complete, generator shall enter cooldown mode, then stop.
d. Include generator exerciser scheduler in the transfer control system.
e. Generator exercising shall also be able to be initiated from the MICROPROCESSOR.

8. Field-Adjustable Transfer Parameters:

   a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range: zero seconds to 30 minutes.
   b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range: zero seconds to 120 seconds.
   c. Delay the transfer from the standby power source to the normal power source. Delay range: zero seconds to 30 minutes.
   d. A relay with contact that changes state when the power is available on the normal source and a relay with contact that changes state when the power is available on the standby source.
   e. Microprocessor shall maintain all programming and field-adjustable settings between transfers or for extended loss of power to the microprocessor.

9. Controls and Indicators: Besides the delay setting controls, provide the following:

   a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers are tripped due to overcurrent or ground fault.
   b. Transfer-control "Manual- Off- Auto" 3-position selector switch.

      1) Hardwire interlock shall prevent paralleling of the two power sources at all times.

   c. Open-close control switch for manual electrical operation of each controlled circuit breaker.
   d. Selector to place control into programming mode.
   e. Circuit-breaker control switch for each of the normal and standby source breakers, providing open and close operation.
   f. Push button to initiate transfer/retransfer in manual mode.
   g. Emergency stop pushbutton (E-Stop) to immediately stop the standby generator or to bypass cool down.
   h. Meters and display to show the following:

      1) Voltage and frequency of both sources.
      2) A multiline display showing the following:

a) Set points of timers, and voltage pickup and dropout set points.
b) Date, time, and reason for at least the last 10 transfers. Display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
c) When the control system is in the transferring process, display shall show delay countdown in seconds.

i. LED indicator lights to show the following:

1) Normal source available.
2) Standby source available.
3) Normal source connected.
4) Standby source connected.
5) Load bus energized.

10. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
11. Voltage Sensing Relays: Microprocessor-based ANSI No. 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with manufacturer's instructions.

E. Pilot lights:

1. LED, full size (22mm), full voltage, push-to-test type.
2. Provide indicators for the following, at a minimum:

a. Utility available and utility breaker open green pilot light.
b. Utility unavailable amber pilot light.
c. Generator available and generator breaker open green pilot light.
d. Generator unavailable amber pilot light.
e. Generator connected and generator breaker closed red pilot light.

F. Pushbuttons:

1. Heavy duty type, full size (22mm).

2. Provide pushbuttons for the following, at a minimum:

    a. Generator Emergency Stop (E-Stop) maintained contact pushbutton.
    b. Manual retransfer momentary contact pushbutton

2.8 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

B. Internal Devices: All circuit breakers, pilot lights, switches, internal devices, terminal blocks, wiring, etc. shall be labeled as indicated on the Drawings and in accordance with Section 16070 Identification for Electrical Systems.

2.9 SHOP AND FACTORY WITNESS TESTING

A. Prior to scheduling the factory witness testing, verify the manufactured switchboard against the Engineer-approved shop drawings including, but not limited to, the One-Line Diagram, internal wiring labels, terminal block tags/labels, etc.

B. Perform manufacturers standard production testing and inspection on switchboards and circuit breakers in accordance with NEMA and UL standards. If requested by the Engineer, the manufacturer shall submit certified copies of test results to indicate proof of compliance with NEMA and UL Standards.

C. The manufacturer shall provide a fully functional factory test to ensure that all manual and automatic equipment operate as specified. Prior to actual factory witness testing by the Engineer and Owner, the manufacturer shall conduct sufficient tests and provide the test reports to the Engineer and Owner to ensure that when the witness test is performed, the equipment will operate as specified.

D. The switchboard shall be tested separate from the engine/generator units. Appropriate current and voltage sources, loads, and input signals shall be provided to simulate actual operating conditions, within the limit of not having actual generator connected to the switchboard. The switchboard is not required to be completely connected for factory witness testing. However, control wiring shall be provided such that the switchboard functions as it will under actual and final operating conditions.

E. At a minimum, perform the following operational tests:

1. Verify that the system performs the sequence of operations as specified including, but not limited to, the following:

    a. Automatic Transfer Controller (ATC) in auto and manual.
    b. ATC operation when exercised locally and remote by SCADA.
    c. Exercise and drawout the electrically operated circuit breakers, verifying there is no change in position during a loss of power event.
    d. Schedule the ATC transfers and exercises the generator on load per NFPA 110.

2. Verify all protective relay functions.
3. Verify that each annunciation point operates correctly. For external alarms, simulate the alarm.

F. The Engineer and Owner shall have the right to inspect, at the factory, all equipment covered by these specifications any time during manufacture and assembly and to be present during any tests made on the equipment.

G. The Engineer and Owner will not visit the manufacturing facility for final performance testing.

H. The manufacturer shall make a technician available to the Engineer and Owner to assist in the inspection and witness test of the switchboard. The technician shall instruct the Engineer and Owner in all functions of the equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03303 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Install spare-fuse cabinet.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 16070 “Identification for Electrical Systems.”

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 16070 “Identification for Electrical Systems.”

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 16070 “Identification for Electrical Systems.”

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Acceptance Testing:

   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test, including primary injection for the circuit breakers, stated in NETA Acceptance Testing Specification (ATS). Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared (IR) scan tests and inspections, and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner. Perform IR scanning in accordance with NETA ATS Section 9 for Thermographic Surveys and NFPA 70B Chapter 7.4 for Infrared Thermography.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 16071 “Power System Studies.”

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 16243

SECTION 16246 – 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 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch circuit panelboards.
3. Circuit breakers.
4. Accessories and special construction.

B. Related Requirements:

1. Section 16010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product used on project. Note this Section may include products not required for the project.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.

6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Include Internet link for electronic access to downloadable PDF of coordination curves.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:

1. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

B. Warranty documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to equipment manufacturer restrictions listed in Section 16010 “Supplemental Requirements for Electrical”, panelboards from the following manufacturers are approved:

1. Eaton.
2. Siemens.
3. Square D by Schneider Electric.

B. Source Limitations:

1. Obtain new panelboards from single source from single manufacturer.

2.2 GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with the following standards as applicable:

1. NEMA PB 1, Panelboards.
2. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
3. UL 50E, Enclosures for Electrical Equipment, Environmental Considerations.
4. UL 67, Standard for Panelboards, CCN QEUY.
5. UL 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
6. UL 1449, Surge Protective Devices.

C. Ratings:

1. Ratings are indicated on the Drawings.
2. Series rated panelboards are prohibited. Circuit breakers must be fully rated for the short circuit rating listed for the panelboard.

D. Construction:

1. NEMA1 enclosure, unless noted otherwise on Drawings. See ACCESSORIES AND SPECIAL CONSTRUCTION Article for enclosures other than NEMA 1.
2. Copper equipment grounding bar, separate and distinct from neutral bar.
3. Conductor Lugs:

    a. Mechanical type.
    b. Size suitable for indicated conductor sizes.
    c. Neutral (when present) and ground lug quantity equal to each pole in panelboard.

4. Where Drawings indicate space for future circuit breaker, equip panelboard with bus bars, blank covers, and mounting hardware so only the future breaker need be provided.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearance between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.3 POWER PANELBOARDS

A. Manufacturer’s power distribution panelboard using molded-case bolt-on circuit breakers, where available. Drawing designation using “PP” or “LP”.

B. Doors: Hinged cover or door-in-door trim when available. Secure door with flush keyed lock and catch, except doors over 36 inches in height to use a vault-type latch with tumbler lock and 3-point catch. All locks keyed alike.

C. Bus: Tin-plated copper.

2.4 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Manufacturer's lighting and appliance panelboard using molded-case bolt-on circuit breakers.

B. Doors: Door-in-door construction with concealed hinges; secured with flush keyed lock and catch, except doors over 48 inches in height to use a vault-type latch with tumbler lock and 3-point catch. All locks keyed alike.

C. Bus: Tin-plated copper.

2.5 CIRCUIT BREAKERS

A. Molded case, manufactured by panelboard manufacturer.

B. Plug-in or bolt-on as listed in associated panelboard Article.

C. Configuration, frame size, trip, and special features such as GFCI (Class A trip, 4-6 mA) or GFI (Class B trip, 30 mA) as shown on Drawings.

D. Provide breaker lugs to accommodate wire sizes shown on Drawings.

E. Multi-pole breakers to have common trip. Do not convert single pole breakers to multi-pole using handle ties, use multi-pole breaker.

F. Thermal-Magnetic Circuit Breakers:

1. Inverse time-current element for low-level overloads.
2. Instantaneous magnetic trip element for short circuits.
3. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

G. Electronic Trip Circuit Breakers:

1. RMS sensing.
2. Field-replaceable rating plug or electronic trip.
3. Adjustable trip functions as indicated on Drawings.

2.6 ACCESSORIES AND SPECIAL CONSTRUCTION

A. Accessories such as breaker lockout devices or key interlocks are indicated on the Drawings.

B. Integral Surge Protective Device:

1. By panelboard manufacturer, factory installed.
2. Type 2.
3. SCCR: Equal to SCCR of panelboard where installed.
4. Performance:

    a. The SPD shall provide all modes of protection based on the system voltage.
    b. The voltage protection ratings (VPRs) shall not exceed the following:

System Voltage	Line-Neutral	Line-Ground	N-Ground	Line-Line
120 (2W+G)	700	700	700	n/a
240 (2W+G)	1200	1200	1200	n/a
120/240 (3W+G)	700	700	700	1200
120/208Y (4W+G)	700	700	700	1200
277/480Y (4W+G)	1200	1200	1200	2000
240Δ (3W+G)	n/a	1200	n/a	1200

c. Minimum surge current ratings per mode shall be as follows:

1) Distribution panels (480V): 100 kA
2) Branch panels and control panels (480V): 100 kA
3) Branch panels (120/208/240 – single or three phase): 50 kA

C. Electronic Grade:

1. Integral SPD.
2. Neutrals: 200 percent rated.

D. NEMA 4X Enclosure:

1. Material: 316 stainless steel.
2. When available, 3-point latch door.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer’s published instructions.

B. Reference Standards for Installation: Unless more stringent requirements are specified in Contract Documents or manufacturer’s published instructions, comply with the following:

1. ANSI/NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
2. NECA NEIS 407 – Standard for Installing and Maintaining Panelboards.

C. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind panelboard.
2. Mount back box plumb and level, and surface or flush mount as indicated on Drawings.
3. Mount surface-mounted panelboards to supports to allow a minimum of 1/2 inch air space between the box and the mounting surface.
4. Mount flush-mounted panelboards with front cover uniformly flush with wall finish and mating with back box.
5. Mount top of trim 72 inches above finished floor unless otherwise indicated.

E. Install circuit breakers not already factory installed. Rearrange circuit breakers to correspond to panel schedules shown on Drawings.

F. Tighten bolted connections and wiring connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

G. Install filler plates in unused spaces.

H. Plug abandoned or unused entry holes.

I. Do not leave cut off wires at breakers, neutral bar terminal, or ground bar terminal.

J. Identify panelboards in accordance with Section 16070 "Identification for Electrical Systems".

1. Identify equipment by name designation and fed from source nameplates.
2. Identify pole numbers.
3. Color code wiring.
4. Identify branch circuit phase and neutral wires by circuit number.
5. Provide as built typed panelboard directory.

K. Adjust circuit breakers with adjustable trips in accordance with the final approved submittal of Section 16071 "Power System Studies".

L. Install Arc Flash Labels in accordance with Section 16071 "Power System Studies".

3.3 FIELD QUALITY CONTROL

A. Perform checkout and testing activities recommended by and in accordance with manufacturer's instructions, NECA 407, and as specified herein. Correct deficiencies, make adjustments, and retest until requirements are met.

B. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with Drawings and Specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify unit is clean.
5. Verify breakers operate smoothly.

C. Electrical Tests:

1. Perform insulation resistance test on buswork in accordance with manufacturer's instructions.
2. Verify correct voltage and phasing at each panelboard.
3. Verify load currents are balanced across the three phases.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of panelboard connections for new or modified panelboards.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform follow-up infrared scan of panelboards, at 11 months after Substantial Completion.
3. Prepare a certified report identifying panelboard checked and describing results of scanning. Include a notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.4 CLEANING

A. Remove rubbish and debris from inside and around equipment. Vacuum clean interior.

END OF SECTION 16246

This page left intentionally blank.

SECTION 16283 – 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 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.
b. Switchboards.
c. Enclosed controllers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01770 "Closeout Procedures," and Section 01782 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Bussmann; Eaton, Electrical Sector.
2. Littelfuse, Inc.
3. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, time delay.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, very fast acting.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Large Motor Branch (601-4000 A): Class L, time delay.
   2. Power Electronics Circuits: Class T, fast acting.
   3. Control Transformer Circuits: Class CC, time delay, control transformer duty.
   4. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Engineer.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 16070 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 16283

SECTION 16286 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Nonfusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

B. Related Requirements:

1. Section 16010 “Supplemental Requirements for Electrical” for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 16011 “Facility Performance Requirements for Electrical” for seismic-load, wind-load, acoustical, and field conditions applicable to Work specified in this Section.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL or a NRTL if approved by the Owner and/or Engineer, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; Schneider Electric USA.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 90 deg C rated wire, sized according to the 75 deg C temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Accessory Control Power Voltage: Integrally mounted, self-powered.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint or Owner approved color and paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1), a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X 316 stainless steel or fiberglass if approved by Owner and Engineer).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts.

D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool

used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X 316 stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.

3.3 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's

published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that the unit is clean.

e. Operate the circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of

manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare an Initial and Follow-up report:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges based on results of Power System Study.

END OF SECTION 16286

SECTION 16293 - SOFT-START MOTOR CONTROLLERS

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 soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.

1. Combination soft-start controllers.
2. Enclosures.
3. Accessories.
4. Identification.

B. Related Requirements:

1. Section 16010 “Supplemental Requirements for Electrical”.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. FLA: Full-load current.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor circuit protector.

E. NC: Normally closed.

F. NO: Normally open.

G. OCPD: Overcurrent protective device.

H. SCCR: Short-circuit current rating.

I. SCPD: Short-circuit protective device.

J. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Product Schedule: For each enclosed controller.

1. Each installed soft-start controller type.
2. Nationally Recognized Testing Laboratory (NRTL) listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.

a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

1) Listing document proving Type 2 coordination.

b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:

    a. Routine maintenance requirements for soft-start controllers and installed components.
    b. Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.
    c. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.
    d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
    e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 32 deg F and not exceeding 104 deg F, humidity noncondensing.
2. Altitude: Not exceeding 3300 feet.
3. The effect of solar radiation is insignificant.

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

2.2 COMBINATION SOFT-START MOTOR CONTROLLERS

A. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor (external to the soft starter) in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rockwell Automation, Inc.
2. Square D; Schneider Electric USA.
3. ABB, Electrification Business.
4. Eaton.
5. Or approved equal.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Standard duty.

1. At least two SCRs per phase to control the starting and stopping of the motor.
2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.

5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
6. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.

E. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

F. Controller Diagnostics and Protection:

1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.

G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

1. Starter Status: "Ready," "starting," "stopping," or "run."
2. Motor current in amperes.
3. Faults:

    a. Motor overcurrent trip.
    b. Motor thermal overload.
    c. Starter thermal fault.
    d. Low line voltage.
    e. Loss of a phase.
    f. Phases reversed.
    g. Maximum stating time exceeded.
    h. Serial communications error.

H. Interface Panel: Mounted on controller door. With plug-in connector and removable.

1. Guarded adjustable set points, not readily accessible.

    a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
    b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
    c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

2. Adjustable set points, readily accessible, password protected.

    a. Linear acceleration, adjustable from 1 to 60 s.

b. Maximum start time, adjustable from 1 to 250 s.
c. Selector switch; select coast to stop or soft stop.
d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features: All outputs shall be prewired to terminal blocks.
1. Form C status contacts that change state when controller is running.
2. Form C alarm contacts that change state when a fault condition occurs.
3. Refer to schematics for additional requirements.

J. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

K. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

2.3 ENCLOSURES

A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.

B. Construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Full size (30mm), heavy duty oil-tight.

a. Push Buttons: As indicated in the controller schedule.

b. Reset Push Button: Guarded.
c. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; non resettable.

2.5 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 16070 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 16070 "Identification for Electrical Systems." Produce a 3-1/2-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

b. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 16057 "Hangers and Supports for Electrical Systems," and bolted to wall.

C. Freestanding Controllers: Provide slotted support systems complying with Section 16057 "Hangers and Supports for Electrical Systems."

D. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03303 "Cast-in-Place Concrete."

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

H. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 16070 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and the Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify that the unit is clean.
    e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
    f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
    g. Inspect Contactors:

        1) Verify mechanical operation.
        2) Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

    h. Motor-Running Protection:

        1) Verify that motor FLA is at, or under, the controller current rating.
        2) Verify that overload element setting is correct for its application.
        3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
        4) If motor-running protection is provided by fuses, verify correct fuse rating.

i. Inspect bolted electrical connections for high resistance using one of the following two methods:

1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.
b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices according to manufacturer's published data.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
f. Test the following parameters according to NETA relay calibration procedures, or as recommended by manufacturer:

1) ANSI No. 49R, Overtemperature Protection:

a) Determine time delay at 300 percent of setting.
b) Determine a second point on the operating curve.
c) Determine pickup.

2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:

a) Determine positive sequence voltage to close the NO contact.
b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
c) Verify negative sequence trip.

d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.

3) ANSI No. 81, Over-frequency Protection:

a) Verify frequency set points.
b) Determine time delay.
c) Determine undervoltage cutoff.

4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.

g. Perform operational tests by initiating control devices.

4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

a. Comply with recommendations of NFPA 70B, Chapter "Testing and Test Methods," Article "Infrared Inspection."
b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:

1) Description of equipment to be tested.
2) Discrepancies.
3) Temperature difference between the area of concern and the reference area.
4) Probable cause of temperature difference.
5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
6) Identify load conditions at time of inspection.
7) Provide photographs and thermograms of the deficient area.
8) Recommended action.

e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
f. Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

C. Motor controllers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 16293

This page left intentionally blank.

SECTION 16296 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

1. Section 16010 “Supplemental Requirements for Electrical”.

1.3 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller. See VFD.

L. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Provide an electrical system harmonic study (analysis) for the electrical system. All design parameters listed in this Section are preliminary and shall be verified by this vendor with the power company prior to submitting the harmonic analysis for review and approval. The harmonic analysis submitted to the Engineer for review and approval shall be accompanied by a letter which certifies that the parameters (i.e. utility system symmetrical short circuit availability for each source of supply) are current and from whom they were obtained.

F. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:

   a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
   b. Manufacturer's written instructions for setting field-adjustable overload relays.
   c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

   e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
   f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Rockwell Automation, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 61800-5-1.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: greater than 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: greater than 95 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
7. Ambient Temperature Rating: Not less than 0 deg C and not exceeding 40 deg C.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, minimum 16 bit, isolated from all power circuits.

H. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

I. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for

providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

J. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

2.3 CONTROLS AND INDICATION

A. Controls shall, as a minimum, perform the control logic indicated on the Contract Drawings and as specified herein.

B. Status Lights and switches: Full size (30mm), heavy duty, oil-tight, door-mounted LED indicators displaying the conditions shown on the Drawings.

C. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

D. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

E. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

F. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
b. A minimum of six multifunction programmable digital inputs.

2. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

3. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

2.4 LINE CONDITIONING AND FILTERING

A. Input Rectifier: Use a transistor-based Active Front End that uses a Selective Harmonic Elimination algorithm, mitigating the harmonics enough to meet IEEE-519 without the need for phase shifting transformers and multi-pulse diode rectifiers.

1. Total current harmonic distortion shall not exceed 5% at the VFC input terminals in all load conditions.
2. Insensitive to phase rotation, tolerant of line voltage imbalance up to 10% without affecting the harmonic mitigation or VFC output, and capable of operating the motor at full output with a 10% drop on input voltage.
3. Use an LCL filter assembly to filter up to and including the 50^{th} harmonic to reduce EMI/RFI emissions.

    a. Include Passive Dampening in LCL filter assembly.

4. Provide Active Resonance Detection and Protection to minimize any damage to the drive from supply side resonance.

B. Output Filtering:

1. Provide output filter for each VFD with motor lead exceed VF manufacturer recommended lead lengths. The output filter shall prevent overstressing motor insulation by reducing transient voltage (dv/dt) at the motor terminals. Output filters shall be load reactor, dv/dt output filter, or sine wave filter required to reduced transient voltage (dv/dt).
2. Filters shall be three-phase, 600-volt class motor-protecting type consisting of suitable values of inductance, capacitance and resistance to form a damped, low pass filter.
3. Filter shall be suitable for mounting within low-voltage variable frequency drive enclosure.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: .NEMA 1
2. Wet or Damp Indoor Locations: Type 4X.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Unguarded.

2. Reset Push Button: Guarded.
3. Pilot Lights: Push to test.
4. Selector Switches: Rotary type.
5. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Supplemental Digital Meters:

1. Elapsed-time meter.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Cooling Fan and Exhaust System: For NEMA 250, Type 1/Type 12; UL 618005-5-1 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.7 ADDITIONAL CONSTRUCTION REQUIREMENTS

A. Disconnect handle height shall not exceed NEC requirements with VFC is located on 4-inch high housekeeping pad.

B. VFC’s shall utilize 115 VAC control power for operator devices, cooling fans, motor space heaters and external control circuits. Control power transformer shall be fused on the primary and secondary. Control circuits shall be isolated from power circuits.

C. VFC shall include a copper ground bus.

D. All bus and exposed copper shall be tin plated.

E. All floor mounted enclosures shall have complete 18" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have

complete 12" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.

F. A switchable fluorescent light shall be provided within each floor mounted section of the enclosure.

G. Barriers shall be provided on terminals that remain energized with the power disconnect OFF.

H. All circuit boards shall be conformal coated to help protect them from hydrogen sulfide gases.

I. Identification

1. All wiring shall be numbered at each end with typed sleeve type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.
2. Provide warning signs on terminals that are energized with the power disconnect OFF.
3. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.
4. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
5. Provide permanent warning signs as follows:

    a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
    b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 16057 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03303 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFC.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 16283 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 16055 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 16070 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer, Construction Manager, & Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Field test all the hardwired discrete and analog connections and any software communication (Ethernet, Profibus, ControlNet, Modibus etc) that are connect to remote control equipment when the VFC is placed in remote. The manufacturer shall at a minimum verify with the proper testing equipment that the following can be achieved:

    a. The drive can be started and stopped remotely
    b. The drive can have its speed changed remotely
    c. The remote equipment can read the VFC discrete status information.
    d. The remote equipment can read the VFC speed feedback information.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor

nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer, Construction Manager, & Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

3.10 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

B. Replace all cabinet ventilation filters upon commencement of the Contract warranty period.

END OF SECTION 16296

SECTION 16501 - LIGHTING

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: Luminaires, components, and accessories.

B. Related Requirements:
   1. Section 16010 “Supplemental Requirements for Electrical” for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 16011 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 DEFINITIONS

A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.

B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.

C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

1.4 ACTION SUBMITTALS

A. Shop Drawings:
   1. Product Data: For each type of product used on project.
      a. Include physical data to confirm compliance with luminaire schedule. Include description, features, accessories, finishes, and dimensions of luminaires.
      b. Include electrical and lighting data to confirm compliance with luminaire schedule. Include voltage, design life, lumen output, CCT, CRI, photometric data, and energy efficiency data.
      c. Organize luminaire data in sequential order based on the luminaire schedule. Use same designations indicated on Drawings.
      d. Include emergency lighting units, including batteries and chargers.
      e. Include support accessories as applicable.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

B. Warranty documentation.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

B. Store luminaires in a dry location in their original packaging, until ready for installation.

1.9 WARRANTY

A. Warranty period for LED luminaires and emergency luminaires with batteries: 5 years.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Luminaires, Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with the following standards and UL Category Control Number (CCN) listing criteria as applicable:
   1. UL 924, Standard for Emergency Lighting and Power Equipment.
   2. UL 1598, Luminaires (non-hazardous locations).
   3. UL 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

2.2 LUMINAIRES

A. Refer to luminaire schedule on Drawings for detailed requirements for each luminaire type. Catalog numbers listed on schedules are provided as a design basis for performance and quality desired. Equivalent design and quality from other manufacturers will be acceptable upon Engineer’s approval.

B. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components to be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.
   4. Steel: ASTM A36/A36M for carbon structural steel, ASTM A568/A568M for sheet steel.
   5. Stainless Steel: Manufacturer's standard grade, ASTM A240/A240M.
   6. Galvanized Steel: ASTM A653/A653M.
   7. Aluminum: ASTM B209.

C. Variations in metal finishes are unacceptable in the same piece.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 16057 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Refer to Drawings for support details.

C. Single-Stem Hangers: 1/2-inchsteel tubing with swivel ball fittings and ceiling canopy. Finish to match fixture.

D. Wires: ASTM A641/A641M, Class 3, soft-temper, zinc-coated steel, 12 gage.

E. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Relevant Article of NFPA 70.
2. NECA NEIS 502 – Standard for Installing Industrial Lighting Systems.

C. Special Installation Techniques:

1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
2. Fasten luminaire to structural support. Comply with requirements in Section 16057 “Hangers and Supports for Electrical Systems”.
3. Comply with requirements in Section 16052 “Low-Voltage Electrical Power Conductors and Cables” and Section 16131 “Conduits for Electrical Systems” for wiring connections and wiring methods.
4. Install luminaires at height and aiming angle as indicated on Drawings.
5. Coordinate layout and installation of luminaires with other construction.
6. Comply with details indicated on Drawings.
7. Comply with requirements in Section 16070 “Identification for Electrical Systems” to identify luminaires, system components, wiring, cabling, and terminals.

3.4 FIELD QUALITY CONTROL

A. Inspect each luminaire for damage and cleanliness. Replace damaged luminaires and components. Remove debris and clean luminaire prior to tests, inspections, and acceptance by Engineer.

B. Perform the following tests and inspections:

1. General Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper control operation in all modes.
2. Emergency Lighting Operational Test: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
3. Emergency Lighting Discharge Test: Interrupt normal power supply and confirm adequate illumination is provided for 90 minutes while on battery power.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare field quality report certifying verification of correct installation.

END OF SECTION 16501

GEOTECHNICAL DESIGN REPORT

Reston Pump Station
Electrical Upgrades
Reston, Virginia

October 2023

CDM Smith

CDM Smith®

cdmsmith.com

Geotechnical Design Report
Reston Pump Station Electrical Upgrades
Reston, Fairfax County, Virginia

October 2023



Prepared by:

Shahin Ghazi Zadeh, P.E.

Geotechnical Engineer

Reviewed by:

Ziad Alem, P.E.

Senior Geotechnical Engineer

Section 1
Introduction

1.1 Project Authorization

CDM Smith has completed a geotechnical engineering study for the Reston Pump Station Electrical Upgrades Project in Reston, Virginia. This study was accomplished in general accordance with the July 1, 2021 Basic Ordering Agreement with CDM Smith, Inc. - Task Order No. 11.

This comprehensive report is a part of the 60% preliminary engineering report (PER) for the project. It presents the results of our field exploration, laboratory testing, and engineering analyses performed to date on the subject project along with providing foundation recommendations for the pump stations components.

1.2 Project Description

Information about this project was provided to CDM Smith by Fairfax County. Information included design drawings for the existing pump station and information related to the electrical upgrades plan. After review of the proposed project scope, it was determined that the following project activities require Geotechnical Engineering analyses:

- Remove the existing transformer and concrete pad, and install a portable generator with trailer (CAT XQ425) on a concrete pad along the same footprint as the existing transformer
- Install a 480-V outdoor pad-mounted transformer on a concrete pad.

According to the provided design drawings, the concrete pads that support the portable generator and the transformer will bear at the ground surface down to the maximum depth of approximately 5 feet below existing ground surface (BEGS), corresponding to elevations of 345 to 350 feet NGVD29.

1.3 Purpose and Scope of Services

The purpose of this study is to explore the subsurface conditions at the site, evaluate applicable foundation types, and provide geotechnical recommendations including construction specifications. Specifically, CDM Smith's geotechnical scope of services consisted of:

- drilling one (1) soil boring to a depth of 25 feet BEGS close to the footprint of the existing transformer;
- conducting laboratory testing on select samples recovered from the field investigation; and
- prepare this geotechnical Design Report to guide others in the electrical upgrades design, outline our field exploration and testing procedures, present available project

information, describe site and subsurface conditions, offer recommendations regarding foundation type and capacity, and provide miscellaneous construction guidance and general considerations.

1.4 Report Limitations

The recommendations in this report have been prepared for the Reston Pump Station Electrical Upgrades project in Reston, Fairfax County, Virginia as understood at this time and described in this report. This report has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. Should changes in design or location of the proposed construction occur, the conclusions and recommendations contained herein should not be considered valid unless verified in writing by CDM Smith.

Section 2
Site and Subsurface Conditions

2.1 Site Location and Description

The Reston Pump Station is located in the eastern side of the Reston, Fairfax County, Virginia. The address to the project site is 1895 Preston White Dr, Reston, Virginia 20191. According to Figure 2-1, the pump station is located within the Preston White Dr, east of the intersection between the Sunrise Valley Dr and South Lake Dr, approximately 120 feet north of Sunrise Valley Dr. The approximate latitude and longitude coordinates for the project site are 38° 56' 30.61'' N and -77° 19' 37.70'' W, respectively, and Surface grade at the project site is approximately at Elev. 350 feet NGVD29. The site is covered with grass and the existing pump station above-ground components. Based on the topography, it was estimated that the direction of surface runoff is to the south. A site location map is presented on Figure 2-1.



Figure 2-1 - Site Location Map

2.2 Drilling, Sampling, and Laboratory Procedures

Geotechnical exploration was conducted on September 13, 2023, and consisted of drilling one (1) soil borings, herein referred to as B-1 to final depth of approximately 25 feet BEGS. A borehole location plan is presented on Figure 2-2. The soil boring was located and staked in the field by a CDM Smith Engineer. According to Figure 2-2, Borehole B-1 was located close to the brick wall

that encapsulate the existing transformer of the pump station. Drilling and sampling were accomplished in general accordance with the applicable ASTM procedures. The log of soil boring B-1 is included in Attachment A.

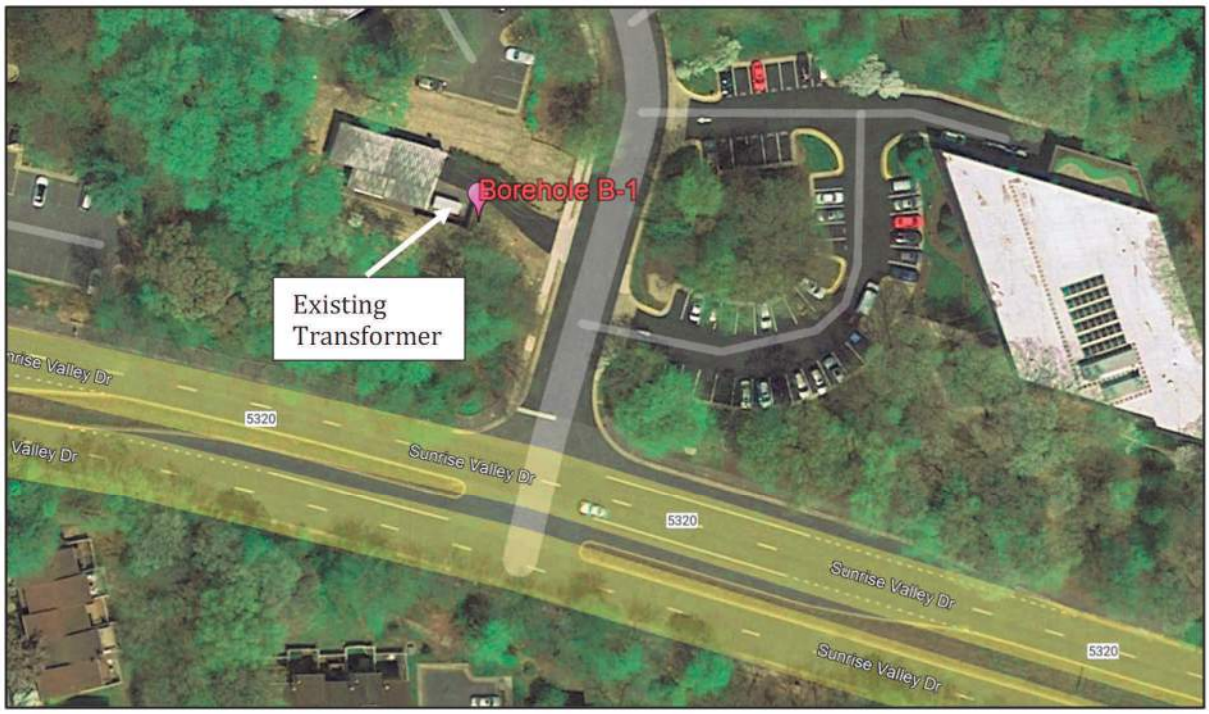


Figure 2-2 – Soil Borings Location

The Standard Penetration Test (SPT) procedure was performed at respective depths intervals to obtain standard penetration values of the soil. The standard penetration value (N), also known as blow count, is defined as the number of blows of a 140-pound hammer-falling 30 inches-required to advance the split-barrel sampler one (1) foot into the soil. To perform the test and obtain the samples, the sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the calibrated hammer. The number of blows is recorded for each of four (4) successive increments of 6-inch penetration intervals. The N-value is obtained by adding the second and third incremental blows to form the blow count. The results of the standard penetration test indicate the relative density of cohesionless soils and thereby provide a basis for estimating the relative resistance and compressibility of the soil profile components. Representative soil samples were obtained utilizing a two-inch O.D. split-barrel sampler in general accordance with the procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM D1586).

Boring B-1 was sampled continuously to approximately 16 feet BEGS then on 5-foot intervals thereafter. The retrieved samples were identified according to the project number, boring number, and depth, then placed in glass jars to protect against moisture loss. The samples were then transported to the geotechnical laboratory for testing. The borehole was backfilled with soil cuttings to a depth of 5 feet BEGS. The remaining five (5) feet were backfilled with gravel.

2.3 Laboratory Testing Program

A laboratory testing program was conducted to evaluate pertinent engineering characteristics of the subsurface materials required to evaluate the behavior of the foundation system for the proposed construction. The laboratory testing program was conducted in general accordance with the applicable ASTM standard procedures. Laboratory testing was performed on selected soil samples to determine the index properties of the subsurface materials. The geotechnical testing program included the following tests:

- Moisture Content (ASTM D2216)
- Atterberg Limits (ASTM D4318)
- Particle Size Analysis (ASTM D6913)

Geotechnical laboratory test results are presented in Attachment B of this report. Table 2-1 summarize the results of the laboratory testing program.

Table 2-1 Geotechnical Laboratory Test Results

Soil Boring	Sample Depth Interval (ft)	Moisture Content (%)	Percent Passing No. 200 Sieve (%)	Plasticity Index (%)	USCS Classification
B-1	6-8	33.8	89.9	13	ML
	12-14	15.8	66.3	NP	ML
	23-25	17.2	78.3	14	ML

2.4 Subsurface Conditions

2.4.1 Regional Geology

From a geological and physiographic viewpoint, Reston, Virginia is underlain by the Piedmont upland Physiographic Province, on the west bank of the Potomac River. Piedmont is the largest Physiographic Province in Virginia, which is characterized by a low relief, gently rolling surface with scattered higher peaks. The Piedmont Upland Physiographic Province occurs in the central portion of the Fairfax County, west of the Coastal Plain and east of the Triassic Basin. The Piedmont Physiographic province is underlain by metamorphic rocks, predominantly micaceous schist, phyllite, granite, gneiss, and greenstone. Piedmont upland soil consists of a capping of silty old alluvium over silty and sandy soil materials weathered from the underlying bedrock. The alluvium capping materials ranges from ½ to 3 feet thick and contains rounded waterworn pebbles. The subsoil can be quite clayey, but the clays are only slightly plastic. The soil is well drained. Depth to hard bedrock in this region is estimated to be between 10 and 100 feet below the surface. Considering the topography, the overall surface runoff drainage is to the south.

2.4.2 Site Stratigraphy

The soils encountered in soil borings B-1 are summarized in tables 2-2. The site stratigraphy is described in detail on the logs of soil borings B-1, included in Attachment A, and is discussed herein.

According to the test boring logs, Topsoil was first encountered within the first 6 inches of the borehole. Then approximately 3.5 feet of soft SILT was encountered followed by an approximately 4-foot-thick layer of medium-stiff CLAY & SILT with various amounts of fine to medium Sand, down to approximately 8 ft BEGS. A 6-ft-thick layer of stiff to very stiff SILT with some sand was encountered from approximately 8 to14 ft BEGS. Then a layer of medium dense Silty SAND with some clayey silt was encountered from approximately 14 to 19 ft BEGS that followed by a very stiff layer of CLAY & SILT with various amounts of sand to the boring's termination depth of approximately 25 feet BEGS.

Table 2-2 General Subsoil Stratigraphy in borehole B-1

Average Boundary Depth (feet)		Average Thickness (feet)	Blow Count Number, N (blows/foot)	Subsoil Description [a]
Top	Bottom			
0	0.5	0.5	N/A	Topsoil
0.5	4	3.5	4	Moist soft SILT some sand
4	8	4	5, 8	Moist medium stiff CLAY & SILT little to some Sand
8	12	4	9, 10	Moist stiff SILT some Sand
12	14	2	18	Moist very stiff SILT some Sand
14	19	5	13, 21	Moist medium dense SAND little to some clayey silt
19	25	6	21, 24	Moist very stiff CLAY & SILT little to some sand

[a] according to the Modified Burmister classification system

2.5 Groundwater Conditions

The groundwater was not encountered either during the drilling or after completion of the borehole. Nevertheless, groundwater could fluctuate due to seasonal precipitation and variations in weather conditions. It is recommended that the Contractor determines the actual groundwater levels at the area prior to the start of construction activities.

Section 3
Evaluation and Recommendations

3.1 General

Geotechnical engineering evaluations have been made as they relate to the Reston Pump Station Electrical Upgrades project. In general, these evaluations are based on the results of the geotechnical investigation described in Section 2 of this report, published correlations with soil properties, and the minimum requirements of the Virginia Uniform Statewide Building Code (the Code). In addition, recommended design criteria are based on performance tolerances, such as soil bearing capacities and allowable settlement, as understood to relate to similar structures.

3.2 Foundation Considerations

The types and bearing depth of foundations suitable for a given structure primarily depend on several factors including the subsurface conditions, the function of the structure, the loads it may carry, the cost of the foundation, and the criteria set by the Design Engineer with respect to vertical total and differential settlement that the structure can withstand without experiencing damage or distress.

Based on the subsurface conditions at the proposed structure locations and the anticipated structural loads, the structures at the Reston Pump Stations (i.e. the portable generator and the transformer) may be supported on shallow foundations. In case the structures are founded on Structural Fill that should extend at least two (2) feet beyond the edge of the foundation, then outward and downward at a slope of one horizontal to one vertical (1H:1V) or to the extents of the temporary excavation support system to suitable bearing soils as described herein. All Structural Fill should be compacted to at least 98 percent maximum dry density as determined per ASTM D698. Prior to fill placement, the granular subgrade should be proof rolled with at least four complete coverages of a vibratory roller.

3.3 Shallow Foundations

The structures may be supported on shallow foundations consisting of spread footings, strip or wall footings, or slab-on-grade, or mat foundations bearing on compacted suitable foundation soils after the removal of undocumented fill and/or unsuitable materials. Replacement with Structural Fill will be required to remove unsuitable soils including peat, organic soils, or any soft, loose, or disturbed soils present at the foundation subgrade. Should continuous footings be planned, they should have minimum width and embedment depth of 18 inches and 24 inches, respectively.

It is our understanding that the proposed new transformer will be founded on a concrete slab-on-grade. Reference to the log of soil boring B-1 in Attachment A indicates that the upper 2 feet of natural soil consist of soft Silt that is not considered to be a suitable bearing surface for the planned foundation. Therefore, we recommend replacing the upper 30 inches of natural soil with

24 inches of cohesive Structural Fill and 6 inches of compacted crushed stone to finished ground surface as described in Sections 4.5.1 and 4.5.3, respectively.

Bearing capacity calculations were performed to estimate the allowable soil bearing capacity/pressure, q_{all}. It includes an adequate factor of safety against failure of the bearing strata. The estimated allowable bearing capacities for the various bearing surfaces at the pump station are listed in Table 3-1.

Table 3-1 Shallow Foundations

Structure(s)	Approximate Bearing Elevation (feet NGVD29)	Foundation Type	Allowable Bearing Capacity/Bearing Pressure, q_{all} (psf)	Order of Total and Differential Settlement (inch)	Notes
Above Ground Structures	350	Shallow Foundation	1500[1,2]	1, 0.5	Upper 30 inches to be replaced with 24 inches of cohesive Structural Fill and 6 inches of crushed stone

Notes:
1. Maximum bearing pressure may exceed the average allowable bearing pressures by up to 20 percent.
2. The allowable net bearing capacity for continuous footings is assumed to be 1,250 psf.

3.4 Design Groundwater Level

As stated in Section 2-5, the groundwater was not encountered during Geotechnical Investigations. Therefore, for design purposes, we recommend that design groundwater level be considered at a depth of 25 feet BEGS (Elev. 325 feet NGVD29).

It is noteworthy to mention that the groundwater could fluctuate due to seasonal precipitation and variations in weather conditions. Therefore, it is recommended that the Contractor determines the actual groundwater levels at the area prior to the start of construction activities. In an event that the groundwater is encountered at depths < 25ft BEGS, the design groundwater must be revised accordingly.

3.5 Resistance to Unbalanced Lateral Loads

Unbalanced lateral loads should be designed to be resisted by friction on the bottom of the foundation. For design purposes, a coefficient of friction of 0.35 should be considered between the concrete and the underlying suitable foundation soils. It is expected that the available friction will be sufficient to resist all unbalanced lateral loads. However, should lateral loads exceed friction available, the surplus loads may be resisted by passive pressures on the foundation, provided the foundations/walls are appropriately designed for resisting passive pressures. A passive pressure resistance of up to a maximum equivalent fluid pressure of 150 pcf may be assumed provided the foundations are backfilled with Structural Fill compacted to a density of at least 98 percent of the maximum dry density as determined by laboratory test ASTM D698. The resistance from the upper two feet of soil should be neglected, due to surface effects and potential

for disturbance due to frost action and other factors. Frictional resistance should be assumed to be mobilized first and to its full capacity before any passive pressure is developed.

3.6 Resistance to Buoyancy

3.6.1 Shallow Foundations

Assuming a design groundwater elevation of 325 feet NGVD29, all structures are expected to be above the groundwater. However, in an event that the design groundwater changes, any structures that extend below the design groundwater level should be designed to resist hydrostatic pressures from the design groundwater level referenced herein using the dead weight of the structure plus weight for earth placed directly over extension to the structure foundations. To design against uplift, the soil used as backfill should be assumed to have a total unit weight, in place, of 120 pcf. A factor of safety of at least 1.25 should be used to evaluate uplift resistance under normal groundwater conditions.

3.6.2 Resistance Methods

At the time of this writing, the design groundwater level was established to be at 25 feet BEGS or Elev. 325 feet NGVD29 at the completion of drilling. This means that the bearing surfaces of the foundation would be above the water table, and therefore, no hydrostatic uplift forces are applicable to the foundations.

Considering the fluctuation of the groundwater, we recommend that groundwater levels be allowed to reach equilibrium for a minimum of 24 hours following the excavation operation to better understand the depth to the water table and determine whether uplift forces would control the design of the foundation systems or not. Should the measured depth to groundwater be less than the design groundwater level then the uplift force must be estimated and compared against the weight of the foundation and the equipment and its components to calculate a factor of safety against uplift. Should the factor of safety be less than 1.25 then anti-buoyancy measures must be incorporated. Uplift may be resisted by adding dead weight to the well, reinforcing the concrete foundation, introducing helical piles that would be attached to the foundation, or a combination of these measures as dictated by the magnitude of the uplift force.

3.7 Slab-on-Grade

Slab-on-grade construction on 12 inches of Structural Fill overlying suitable bearing soils should assume a coefficient of subgrade reaction of 125 pounds per cubic inch (pci). The coefficient of subgrade reaction is measured by means of a square plate measuring 1 foot by 1 foot and should be adjusted for size effects. The following equation is applicable for correcting the k-value for rectangular foundations bearing on sand:

$$k_{sand} = k^* ((B+1)/2B)^2$$

Where,

k = typical subgrade reaction value (pci), B = width of the foundation (ft); and
k_{sand} = coefficient of subgrade reaction of foundation

3.8 Seismic Considerations

For determining design earthquake forces for the structures in accordance with the Code, the site should be considered as Site Class "E". Therefore, the spectral accelerations shall be modified for Site Class E when determining the design earthquake response accelerations and seismic design category for the seismic analysis at the site.

3.9 Yard Piping

3.9.1 General

The proposed yard piping should be installed by cut-and-cover methods in excavated trenches. Based on the test borings, it is likely that the excavation for the yard piping may encounter materials from soft SILT with sand to medium stiff CLAY & SILT with sand.

3.9.2 Pipe Bedding

The existing subsurface materials along the pipelines are generally considered suitable for support of the proposed yard piping. Crushed stone should be placed around the pipelines and extend from a minimum of 6 inches below the pipe to the pipe springline. Prior to crushed stone fill placement, soil subgrades should be compacted with at least two passes of the appropriate compaction equipment. Organic, loose, soft, or otherwise unsuitable soils that are encountered at the subgrade level should be excavated to the top of the naturally deposited suitable inorganic soils or to a maximum depth of four feet below the pipeline invert and replaced with compacted Structural Fill or crushed stone. The lateral limits of the Structural Fill or crushed stone should be defined as a line extending horizontally outward and downward at a 1H:1V slope from the springline of the pipe.

At locations where crushed stone is placed below the design groundwater level and over or against fill or fine-grained soils, a geotextile should be placed between the fill or fine-grained soils and the crushed stone to prevent the migration of fines into the pipe bedding. Geotextile is not required where the crushed stone is placed above the design groundwater level.

3.9.3 Trench Backfill

In paved areas, the remainder of the trench backfill, to the underside of the pavement section, should consist of Select Common Fill and be placed and compacted to at least 95 percent of maximum dry density as determined by ASTM D698. Where the trench is within roadways, restoration of the pavement subgrade and paving should be consistent with the existing roadways. In non-paved areas, the remainder of the trench should be backfilled using Common Fill and be placed and compacted to at least 92 percent of maximum dry density as determined by ASTM D698.

The trench excavated soils may be re-used to backfill the trench provided that these soils meets the requirements on Select Common Fill or Common Fill, specified in Section 4.5.

Section 4
Construction Considerations

4.1 General

It is our opinion that methods, means and sequence of the proposed construction should be the responsibility of the project Contractor who should be specialized in this type of construction. However, some general geotechnical considerations are given herein for general guidance, but it is the responsibility of the Contractor to identify and select the most appropriate construction methods, means and sequence needed to meet the specific project requirements, specifications, and schedule.

The purpose of this section is to discuss issues related to geotechnical aspects of construction as required for development of the Contract Documents. Included are anticipated methods of construction required to achieve the recommendations presented herein and identification of potential construction-related problems. The proposed structures are within and adjacent to existing facilities that will be demolished prior to construction, and the impact of construction on those facilities has also been considered herein.

The Contractor will be required to base their construction methods and cost estimates on an *independent interpretation of the subsurface conditions.*

4.2 Excavation and Excavation Support

Considering the shallow depths of foundation systems, it is anticipated that excavation for foundations can be made using conventional excavation equipment and open cut excavations. Excavations for the project are anticipated to encounter soil strata listed in Tables 2-2 of Section 2.4. Undermining of existing foundations or utilities must not occur. Excavation should not extend into the zone of influence of any existing structures or utilities without an approved excavation support system and/or underpinning system. The zone of influence is defined as extending 2 feet beyond the bottom exterior edge of the existing foundation then down and away at a 1H:1V slope or at a 1H:1V slope from the springline of the utility.

The Contractor will be responsible for conducting the excavation work in accordance with the applicable Federal and state laws and regulations, including Occupational Safety and Health Administration (OSHA). Where open excavations are feasible, the side slopes should be designed in accordance with OSHA regulations. The Contractor should be responsible for selection and the design of the means and methods for excavation and excavation support such as open cut with stable side slopes, trench box, soldier pile and lagging, etc.

Use of excavation support may limit the amount of excavation spoils and serve to protect adjacent structures, utilities, and roadways. Selection of the temporary excavation support systems will be dependent upon subsurface and groundwater conditions, adjacent structures, surcharge loading, etc. Trench box systems should not be permitted within the zone of influence of existing structures or utilities. The Contractor should develop an excavation plan, including excavation

support systems designed by a Professional Engineer licensed in the Commonwealth of Virginia. Additional design considerations may be required based on the Contractor's planned construction methods.

4.3 Dewatering

Based on the geotechnical investigation data, groundwater is not anticipated within the excavation zone. However, contractor shall determine the actual groundwater levels at the area prior to the start of construction activities. If the groundwater is encountered within or near (i.e within 2 feet below) the excavation zone, the contractor will be responsible to prepare for, design, and implement a dewatering and drainage system that maintains a stable, undisturbed subgrade that is free from groundwater and surface water during all construction operations. To avoid disturbance of the subgrade, the water level in all excavations should be maintained at least two feet below the subgrade level during the entire period of excavation and fill placement. The design of the dewatering system should be performed by a Professional Engineer licensed in the Commonwealth of Virginia.

Where applicable, the dewatering system should be designed in conjunction with an excavation support system selected by the Contractor. Depending on the depth of the excavation and excavation support system selected, wells, well points and/or pumping from open sumps within the excavation may be required. Wells, well point and sumps must be adequately filtered to avoid loss of fines.

The site should be graded to direct surface runoff away from the excavations. If wet weather is encountered during construction, the Contractor should take care to schedule excavations to limit the duration of open cuts, slope the bottoms of the excavations to facilitate drainage and provide berms to limit runoff into the excavations. In addition, excavated material should be stockpiled in such a manner that promotes runoff and limits saturation of the materials. If the surficial soils become softened during wet weather or become frozen, these soils may need to be scarified and re-compacted or removed before additional fill is placed.

The Contractor must be prepared to operate the dewatering system continuously, as required to complete the work and avoid floatation or uplift prior to completion of the facility. During periods where failure of the system would adversely impact work completed, the Contractor should provide a back-up system to ensure continuous operation.

The Contractor must design the dewatering system to not adversely impact adjacent structures or site features. All dewatering, handling and disposal of pumped water and any special testing should be conducted in accordance with Federal, state and local regulations, permits and specified requirements.

4.4 Protection and Preparation of Subgrade Soils

Care should be taken to avoid excess traffic on the excavated subgrade prior to placement of the Structural Fill, crushed stone, concrete foundations, or pipe bedding materials. Final excavation should be made using a smooth-edged bucket where possible. The exposed subgrade should be protected against precipitation, and the subgrade should not be allowed to freeze. Under no

circumstances should fill or foundation concrete be placed on a disturbed, wet, or frozen subgrade.

Granular soil subgrades should be proofrolled with a vibratory compactor for at least four passes for the structures and two passes prior to placement of fill or pipe bedding. If fine-grained materials are anticipated at subgrade, the final six inches of the excavation should be performed by smooth-edge bucket. Any unsuitable material present at the subgrade level should be removed and replaced with compacted Structural Fill or crushed stone wrapped in geotextile as recommended herein. A working mat consisting of Structural Fill (12-inch minimum) is required below all structures.

4.5 Backfill

4.5.1 Structural Fill

Structural Fill below foundations should consist of a mineral soil free of organic material, loam, debris, frozen soil or other deleterious material which may be compressible, or which cannot be properly compacted. Structural Fill consisting of granular materials should conform to the following gradation requirements in **Table 4-1.**

Table 4-1. Structural Fill Gradation

U.S. Standard Sieve Size	Percent Passing by Weight
3 inches	100
No. 4	20 to 90
No. 40	5 to 75
No. 200	0 to 40

Cohesive fill used as Structural Fill should have a liquid limit between 30 and 42 percent, and a plasticity index between 10 and 20 percent, and a maximum dry density of at least 100 pounds per cubic foot (pcf) as determined by ASTM D698.

Structural Fill should be placed in 8-inch-thick loose lifts and compacted with suitable equipment to at least 98 percent of maximum dry density as determined by ASTM D698. Lift thickness should be reduced to 4 inches in confined areas accessible only to hand-guided compaction equipment. Structural Fill should be placed within minus two to plus two of its optimum moisture content.

4.5.2 Common Fill and Select Common Fill

Common Fill should consist of soil free of roots, vegetative matter, organic material, topsoil, loam, waste, debris, highly micaceous silt, frozen soil, or other objectionable material. It should not contain stone blocks, broken concrete, masonry rubble, or other similar materials. It should have physical properties such that it can be readily spread and compacted. It should not contain stones no larger than six inches and have a maximum of 75 percent passing the No. 200 sieve, a maximum liquid limit of 60 percent, a maximum plasticity index of 30 percent, and exhibit a dry density of at least 90 pcf as determined by ASTM D698. Select Common Fill should meet the criteria of Common Fill except it should contain stones no larger than 2 inches.

Common Fill and Select Common Fill should be placed in maximum 12-inch-thick loose lifts and compacted with suitable compaction equipment to at least 92 and 95 percent, respectively, of the maximum dry density as determined by ASTM D698. Lift thickness should be reduced to 6 inches in confined areas accessible only to hand-guided compaction equipment. Common Fill and Select Common Fill should be placed within minus three to plus three percent of its optimum moisture content.

Based on the available data, we anticipate the excavated fill layers may meet the above criteria and may be suitable for use as Common Fill and/or Select Common Fill.

4.5.3 Crushed Stone

Crushed stone should consist of hard, durable, angular or subangular particles of proper size and gradation and should be free of sand, loam, clay, excess fines, and other deleterious materials. The material should conform to the requirements for Virginia Department of Transportation (VDOT) No. 57 stone.

Crushed stone should be placed in maximum 6-inch-thick loose lifts and compacted with suitable compaction equipment to a firm, unyielding condition. Lift thickness should be reduced to 4 inches in confined areas accessible only to hand-guided compaction equipment.

4.6 Geotextile

A non-woven geotextile should be used to separate crushed stone from the underlying subgrade soils to prevent the migration of fines. Geotextile should be Mirafi 160N or equivalent.

4.7 Construction Monitoring

It is recommended that a qualified Geotechnical Engineer or experienced technician under the direction of the Geotechnical Engineer be present during construction to confirm that the Contractor complies with the intent of these recommendations. Specifically, the field representative would undertake the following responsibilities:

- Monitor the excavation and installation and performance of excavation support systems.
- Confirm measurement of the groundwater levels, by the contractor at the area prior to the start of construction activities.
- Confirm that appropriate dewatering and surface water control methods are employed.
- Confirm the removal of unsuitable materials present at foundation subgrade level and replacement with proper backfill material.
- Confirm that the subgrades are prepared, and conditions encountered are suitable for support of the proposed structures.
- Monitor ACGP load test and production ACGP installation.
- Observe, test and document placement and compaction of backfill material, where appropriate. Samples of imported fill should be submitted to the Engineer for approval prior to starting this work.

In addition, the field representative would be present to identify and provide response should conditions encountered differ from those assumed during preparation of this report.

4.8 Closing

These recommendations have been prepared for the Reston Pump Station Electrical Upgrades project in Fairfax County, Virginia as understood at this time and described in this report. These recommendations have been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. In the event that changes in the design or location of the alignment occur, the conclusions and recommendations contained herein should not be considered valid unless verified in writing by CDM Smith.

Attachment A

Soil Boring Logs

Boring Number: B-1

Client: City of Fairfax
Project Name: Reston Pump Station Replacement
Project Location: Reston, VA
Project Number: 285126

Drilling Contractor/Driller: Stratified, Inc./M. Anderson
Surface Elevation (ft): NA
Drilling Method/Bore Hole Diameter: HSA/2.25 in.
Total Depth (ft): 25.0
Hammer Style/Weight/Drop Height/Spoon Size: Automatic/140 lb/30 in./2 in.
Depth to Initial Water Level (ft):
Depth **Date** **Time**
NE
Bore Hole Location:
Lat: 38.9418380 **Long:** -77.3271410
Abandonment Method:
Drilling Date: **Start:** 9/13/2023 **End:** 9/13/2023
Logged By: S. Ghazi Zadeh

Elev. (ft)	Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
0.0	0								TOP SOIL	6": Topsoil.	
		SS	S-1	24	1 2 2 4	16	4		SILT	Moist, soft, brown, SILT, some fine sand.	
		SS	S-2	24	4 2 2 3	16	4				
-5.0	5	SS	S-3	24	4 4 4 5	16	8		CLAY & SILT	Moist, M. Stiff, red to brown, CLAY & SILT, some fine sand.	
		SS	S-4	24	5 2 3 4	24	5			Moist, M. Stiff, red to brown, CLAY & SILT, little fine sand.	
		SS	S-5	24	3 4 5 7	24	9		SILT	Moist, Stiff, red to brown, SILT, some fine sand.	
-10.0	10	SS	S-6	24	4 5 5 5	18	10			Moist, Stiff, brown, SILT, some fine to med. sand.	
		SS	S-7	24	6 9 9 14	24	18			Moist, V. Stiff, brown to tan, SILT, some fine to med. sand.	
									SAND	Moist, M. Dense, brown to tan, fine SAND, some clayey silt.	

Sample Types

AS - Auger/Grab Sample
CS - California Sampler
NQ - 1.9" Rock Core
NX - 2.2" Rock Core
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
GP - Geoprobe

Consistency vs Blowcount/Foot

Granular (Sand):

V. Loose:	0-4	Dense:	30-50
Loose:	4-10	V. Dense:	>50
M. Dense:	10-30		

Fine Grained (Clay):

V. Soft:	<2	Stiff:	8-15
Soft:	2-4	V. Stiff:	15-30
M. Stiff:	4-8	Hard:	>30

Burmister Classification

and	50 - 35%
some	35 - 20%
little	20 - 10%
trace	< 10%

moisture, density, color

Reviewed by: **Date:** **Boring Number: B-1**

CDM Smith

Boring Number: B-1

Client: City of Fairfax

Project Name: Reston Pump Station Replacement

Project Location: Reston, VA

Project Number: 285126

Elev. (ft) / Depth (ft)	Sample Type	Sample Number	Sample Length (in)	Blows per 6 inches	Sample Recovery (in)	N-Value	Graphic Log	Strata	Material Description	Remarks
-15.0 / 15	SS	S-8	24	4 5 8 12	24	13		SAND	Moist, M. Dense, brown to tan, fine SAND, some clayey silt.	
	SS	S-9	24	5 8 13 23	24	21			Top 12": Moist, M. Dense, brown, fine to med. SAND, little clayey silt.	
-20.0 / 20								CLAY & SILT	Bottom 12": Moist, V. Stiff, brown, CLAY & SILT, little fine sand.	
	SS	S-10	24	8 11 13 23	24	24			Moist, V. Stiff, brown, CLAY & SILT, some fine sand.	
-25.0 / 25									Test boring terminated at 25.0 feet bgs.	
-30.0 / 30										

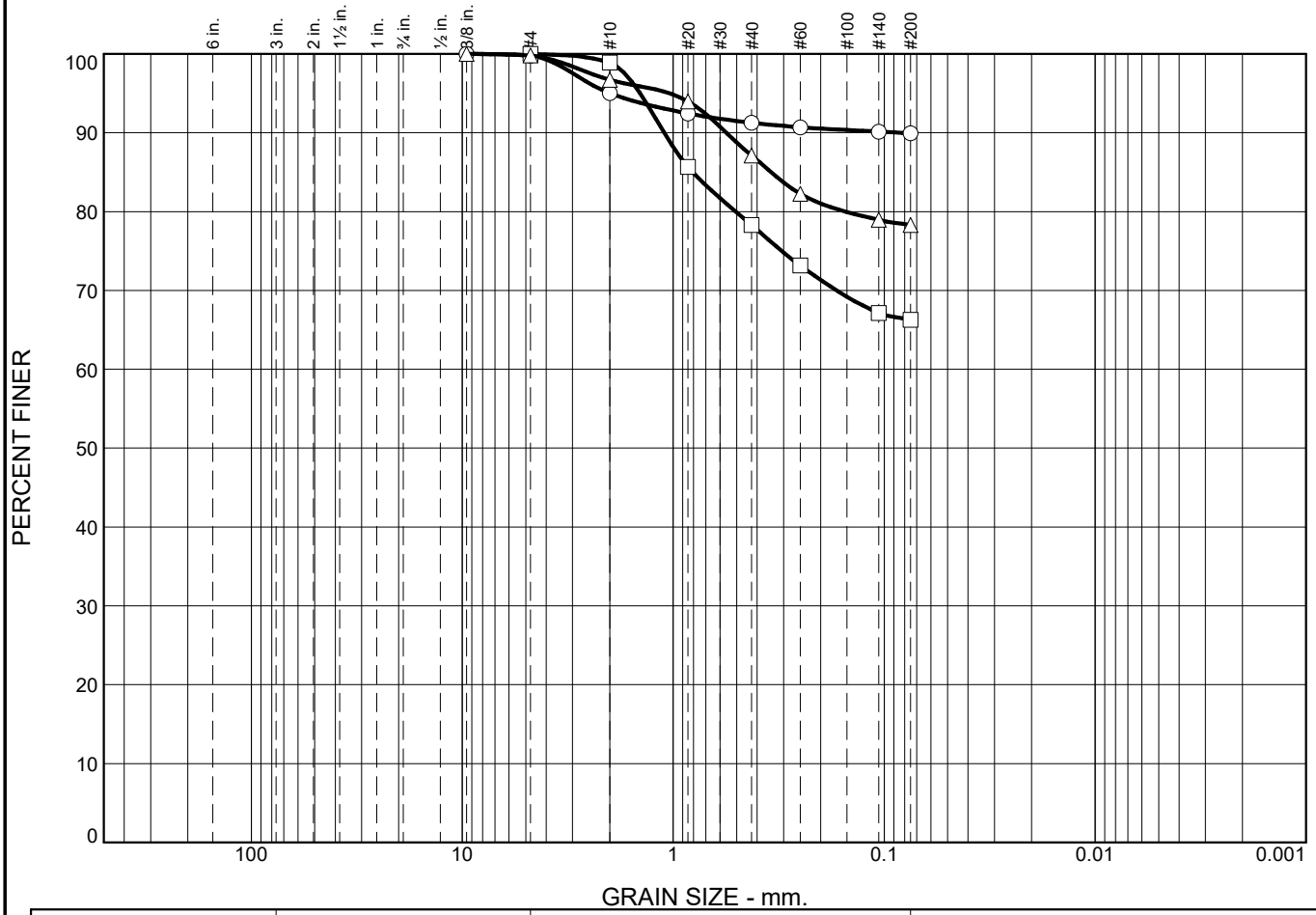
This page intentionally left blank.

Attachment B

Laboratory Test Reports

Particle Size Distribution Report

ASTM D422



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.2	4.8	3.7	1.4	89.9	
□	0.0	0.0	0.0	1.1	20.6	12.0	66.3	
△	0.0	0.0	0.2	3.1	9.6	8.8	78.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_u
○	44	31								
□	NV	NP	0.8070							
△	44	30	0.3439							

	Material Description	Test Date	USCS	NM
○	SILT, ML A-7-5(14)	09/22/23	ML	
□	SANDY SILT,ML A-4(0)	09/22/23	ML	
△	SILT WITH SAND,ML, A-7-5(12)	09/22/23	ML	

Project No. **Client:** Reston Pump Station Replacement

Project: Reston Pump Station Replacement

○ **Location:** Fairfax County **Depth:** 6-8 **Sample Number:** S-4

□ **Location:** Fairfax County **Depth:** 12-14 **Sample Number:** S-7

△ **Location:** Fairfax County **Depth:** 23-25 **Sample Number:** S-10

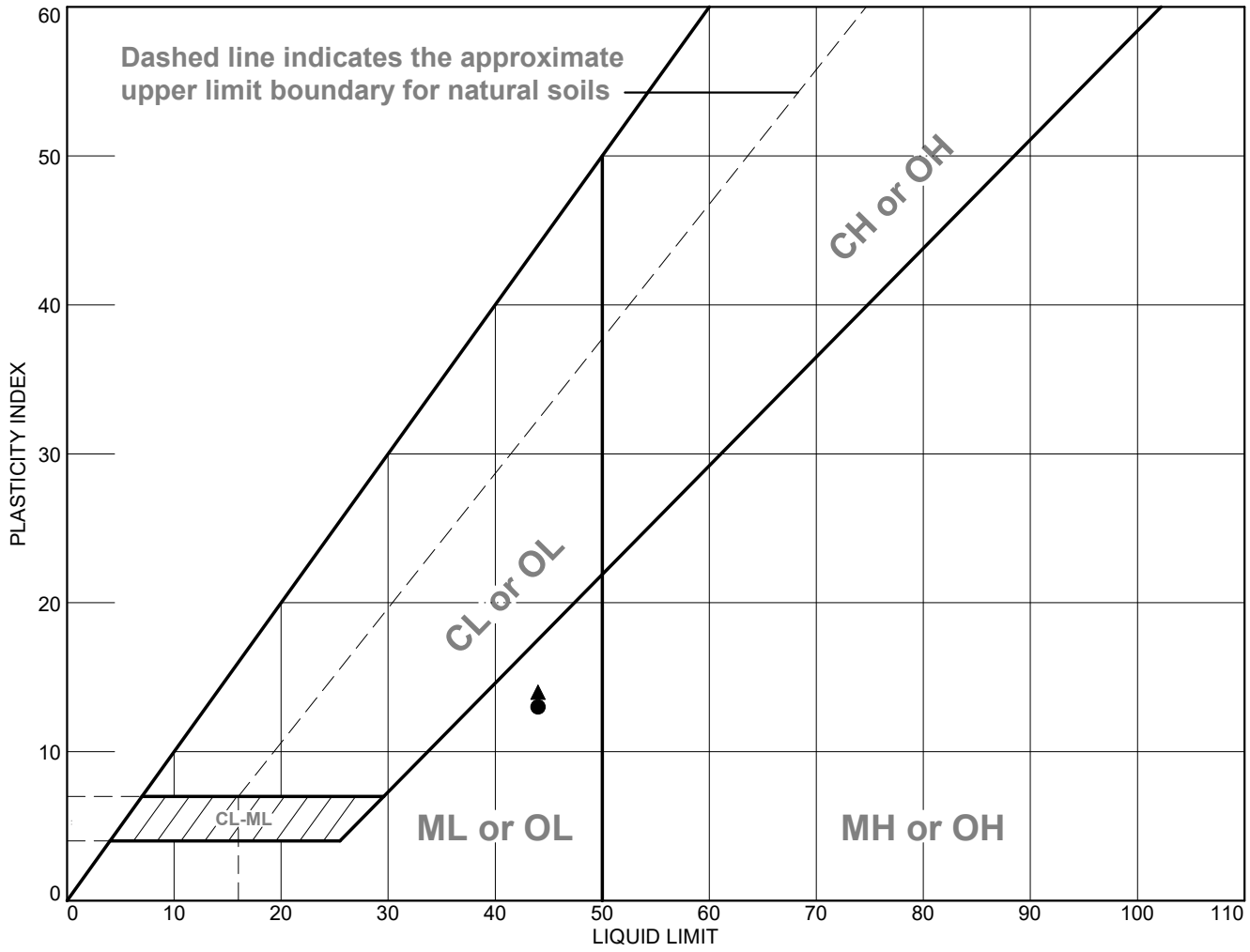
Remarks:

GIT ENGINEERING GEOTECHNICAL, INSPECTION, TESTING

Figure

Checked By: SA

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	SILT, ML A-7-5(14)	44	31	13	91.3	89.9	ML
■	SANDY SILT,ML A-4(0)	NV	NP	NP	78.3	66.3	ML
▲	SILT WITH SAND,ML, A-7-5(12)	44	30	14	87.1	78.3	ML

Project No. **Client:** Reston Pump Station Replacement

Project: Reston Pump Station Replacement

● **Location:** Fairfax County **Depth:** 6-8 **Sample Number:** S-4

■ **Location:** Fairfax County **Depth:** 12-14 **Sample Number:** S-7

▲ **Location:** Fairfax County **Depth:** 23-25 **Sample Number:** S-10

Remarks:

GT ENGINEERING GEOTECHNICAL, INSPECTION, TESTING

Figure

Tested By: TG **Checked By:** SA

Moisture Content ASTM D-2216

Performed Date: **9/22/2023**

Project No.: Project Name : **Reston Pump Station Replacement**

Calculated By: **SA**

		Boring No.	**B-1**	**B-1**	**B-1**			
		Sample No.	S-4	S-7	S-10			
		Depth(ft)	6-8	12-14	23-25			
		Street Name						
		Station No.						
		Tare No.	SA-26	SA-13	SA-27			
		Wet Mass Sample + Tare (g)	125.06	143.91	120.54			
		Dry Mass Sample + Tare (g)	101.40	128.51	107.48			
		Mass Tare (g)	31.43	31.17	31.41			
		Moisture Content (%)	33.8	15.8	17.2			
		Comments						

		Boring No.						
		Sample No.						
		Depth(ft)						
		Street Name						
		Station No.						
		Tare No.						
		Wet Mass Sample + Tare (g)						
		Dry Mass Sample + Tare (g)						
		Mass Tare (g)						
		Moisture Content (%)						
		Comments						

		Boring No.						
		Sample No.						
		Depth(ft)						
		Street Name						
		Station No.						
		Tare No.						
		Wet Mass Sample + Tare (g)						
		Dry Mass Sample + Tare (g)						
		Mass Tare (g)						
		Moisture Content (%)						
		Comments						

Fairfax County, Virginia

BUILDING PERMIT
Commercial Addition/Alteration

Permit Number: ALTC-2024-00304

Issued Date: 08/06/2024

Job Address: 11030 Sunrise Valley Dr
Reston, VA 20191

Tax Map ID 0271 01 0005

Tenant: Reston Pump Station Electrical Upgrades

Bldg: **Floor:** **Suite:**

Owner/Tenant:

8560 Arlington Boulevard
Fairfax, VA 22031

Contractor:
Owner as Contractor

Structure: Public Service Use/Fire/Police

Code: 2018 Virginia Construction Code

Group(s): U

Type of Construction: IIB

Has permission, according to approved plans, applications and restrictions of record to:
Remove portion of existing concrete pads and brick walls / Build generator pad and transformer enclosure / interior alteration to Reston pump station

Work is generally described as the replacement of all electrical equipment in the Reston pump station. The Project will include the demolition of the existing utility transformer and its replacement, to be coordinated with Dominion Energy. Additionally, HVAC improvements are required including upsizing the equipment to meet the heat demands of the new equipment.

BUILDING OFFICIAL: Jay S. Riat

- A copy of this permit must be posted at the construction site for the duration of the permit.
- This permit does not constitute approval from your homeowners' association and its related covenants.
- This permit will expire if work does not commence in six months or if work is suspended for six months.
- Contact VA 811 before you dig at 811 or VA811.com.
- The permit holder is responsible to schedule inspections at plus.fairfaxcounty.gov/CitizenAccess when stages of construction are reached that require inspections.
- For questions regarding this permit email *LDSbuildingpermits@fairfaxcounty.gov* or call 703 -222-0801, TTY 711.

Land Development Services
12055 Government Center Parkway
Fairfax, Virginia 22035
703-324-1780, TTY 711
www.fairfaxcounty.gov/plan2build

Fairfax County, Virginia

BUILDING PERMIT
Commercial Retaining Wall

Permit Number: WALLC-2024-00063 **Issued Date:** 08/06/2024

Job Address: 11030 Sunrise Valley Dr
Reston, VA 20191 **Tax Map ID** 0271 01 0005

Tenant: **Bldg:** **Floor:** **Suite:**

Owner/Tenant:

8570 Executive Park Av
Fairfax, VA 22031

Contractor:
Owner as Contractor

Structure: Public Service Use/Fire/Police **Code:** 2018 Virginia Construction Code

Group(s): U **Type of Construction:** IIB

Has permission, according to approved plans, applications and restrictions of record to:
Child record: Retaining wall for a new transformer Pump Station.

BUILDING OFFICIAL: Jay S. Riat

- A copy of this permit must be posted at the construction site for the duration of the permit.
- This permit does not constitute approval from your homeowners' association and its related covenants.
- This permit will expire if work does not commence in six months or if work is suspended for six months.
- Contact VA 811 before you dig at 811 or VA811.com.
- The permit holder is responsible to schedule inspections at plus.fairfaxcounty.gov/CitizenAccess when stages of construction are reached that require inspections.
- For questions regarding this permit email *LDSbuildingpermits@fairfaxcounty.gov* or call 703 -222-0801, TTY 711.

Land Development Services
12055 Government Center Parkway
Fairfax, Virginia 22035
703-324-1780, TTY 711
www.fairfaxcounty.gov/plan2build