



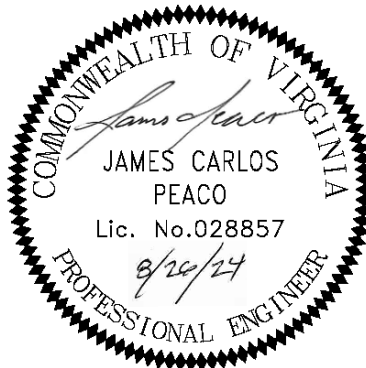
8570 EXECUTIVE PARK AVENUE
FAIRFAX, VIRGINIA 22031

Invitation for Bids No. 24-214

PROJECT MANUAL FOR Project 2722, Division 003

POPES HEAD PUMPING STATION ELECTRICAL UPGRADES

August 2024



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Fairfax Water
Fairfax, Virginia
Popes Head Pumping Station Electrical Upgrades
Project P2722, Division 003

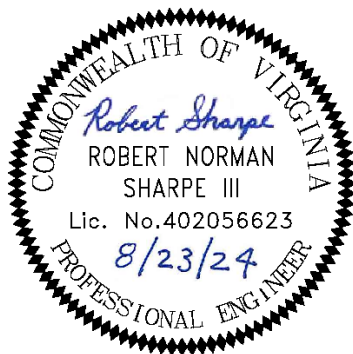
James Carlos Peaco, P.E.
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The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual:

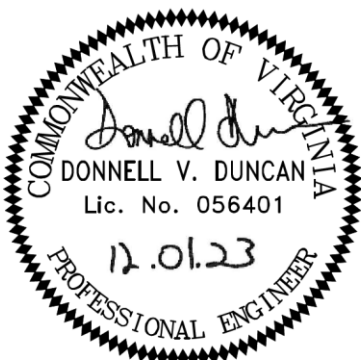
- **Divisions 01, 02, 15**

Robert Norman Sharpe III, P.E.
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The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual:

- **Divisions 13 and 16**

Donnell V. Duncan, P.E. 402056401 	The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual: • Divisions 03 and 05
Errol Antonio Dawkins 401017807 	The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual: • Divisions 04, 06, 07, 08, 09

Engineer's seal and signature does not apply to the documents that comprise Division 00, Bidding and Contracting Requirements.

It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this Project Manual.

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END OF SECTION 00010

SECTION 01110
SUMMARY OF WORK
AND MISCELLANEOUS 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 demolition and replacement of existing electrical equipment at Popes Head Pumping Station including modifications and other miscellaneous related construction activities to provide for the proper and successful completion of the Work. 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 Drawings and 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. 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

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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
- B. Section 01500 – Temporary Controls
- C. Section 16050 - General Provisions for Electrical Systems
- D. Section 16271 - Dry-Type Low-Voltage Distribution Transformers
- E. Section 16273 - Pad Mounted Liquid Filled Transformers
- F. Section 16341 - Medium-Voltage Metal Enclosed Switchgear
- G. Section 16349 - Medium-Voltage Motor Starters

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 operational interruptions provided for under this section.
- B. Pump Station Control Panel Power: The pump station PLC control panel shall not be permitted to be taken out of service during construction. The Contractor shall provide temporary power to the pump station's PLC control panel, when permanent utility power is not available. Noise control for all Work shall be in accordance with Section 01500-1.08.C.
- C. 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.
- D. 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.
- E. 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.

- F. 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.
- G. All costs associated with maintaining the existing facilities in operation shall be included in Contract Item No. 1 and no separate payment will be made therefor.
- H. The Contractor shall not operate or adjust the operation of any existing facility except under the specific direction of the Owner or Engineer.
- I. The Contractor shall at all times maintain Owner access to sample stations and areas that must be accessed for facility operations.

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. Contractor shall provide 28 calendar days written notification prior to taking a pump or the pump station out of service.
- D. 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.
- E. Any temporary structures, connections, piping and other work necessary to maintain service during the construction period shall be provided and made as part of the work under Contract Item No. 1 and no separate payment will be made therefor.
- F. 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.

- G. 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.
- H. 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.
- I. The Contractor shall maintain safe passage through all access roads to existing facilities and to all parts of existing facilities.
- J. 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.
- K. 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.
- L. The Contractor shall be permitted to remove the Popes Head Pumping 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 Reston Pump 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.
- M. The contractor shall be permitted to remove one 350 horsepower motor for shipment to rewinding facility up to 30 days prior to the 90 consecutive day pump station shutdown.
- N. The facility shall not be taken out of service until all equipment has been delivered to the site or has been delivered to a contractor's off-site storage location and ready for installation. The only exception is the second 350 horsepower motor described in Section 01140, 1.04, M.

END OF SECTION 01140

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 and other items selected by the Owner as defined herein and under each Bid Allowance item. No Contractor mark-up shall be permitted for such invoices. The Contractor shall include under other items all of his costs including profit and overhead associated with processing of invoices and all

costs related to his participation in activities covered under Bid Allowances. 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.
- D. "Bid Option": Contract Items in the Bid Form that are designated "Bid Option" cover certain items that may or may not be selected by the Owner for construction. If a bid alternative is selected by the Owner, the lump sum price bid for that Contract Item will be included in the Contract Sum. 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 selected by the Owner for construction.

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 2A (Lump Sum): All Work to Complete Project 2722 Division 003, Except that included in Other Contract Items.

- a. Under this Contract Item, The Contractor shall furnish all labor, materials, equipment and services, and do all work for the construction, maintenance, maintaining plant operations, testing and placing in trouble-free operation all equipment, structures, and appurtenances. The work includes installing all equipment, and all general, electrical structural, architectural and instrumentation work complete and in place, together with all appurtenant work as shown on the Drawings, specified and directed by the Engineer. Work shall also include preparation of Record Drawings in accordance with Section 01780, Operation and Maintenance data in accordance with Section 01782, and Schedule Updates in accordance with Section 1320.
 - b. Lump sum unit of measure and payment.
2. Contract Item 2B (Bid Allowance): Additional site/civil improvements, if required and authorized by Owner.
 - a. Allowance of \$25,000 for additional site/civil improvements which may be required in addition to that shown or specified and as directed by the Engineer. If during the Work, it is found that additional work is required and is authorized in writing by the Owner, this Work shall be paid for under this bid allowance.
3. Contract Item 2C (Bid Allowance): Additional electrical improvements, if required and authorized by Owner.
 - a. Allowance of \$125,000 for additional electrical improvements which may be required in addition to that shown or specified and as directed by the Engineer. If during the Work, it is found that additional work is required and is authorized in writing by the Owner, this Work shall be paid for under this bid allowance.
4. Contract Item 2D (Bid Allowance): Additional structural improvements, if required and authorized by Owner.
 - a. Allowance of \$75,000 for additional structural improvements which may be required in addition to that shown or specified and as directed by the Engineer. If during the Work, it is found that additional work is required and is authorized in writing by the Owner, this Work shall be paid for under this bid allowance.
5. Contract Item 2E (Bid Allowance): Additional instrumentation improvements, if required and authorized by Owner.
 - a. Allowance of \$50,000 for additional instrumentation improvements which may be required in addition to that shown or specified and as directed by the Engineer. If during the Work, it is found that additional work is required and is authorized in writing by the Owner, this Work shall be paid for under this bid allowance.
6. Contract Item 2F (Bid Allowance): Additional new service duct and casing work under Popes Head Road, if required and authorized by Owner.
 - a. Allowance of \$20,000 for additional new service duct and casing work under Popes Head Road which may be required in addition to that shown or specified and as directed by the Engineer. If during the Work, it is found that additional work is required and is authorized in writing by the Owner, this Work shall be paid for under this bid allowance.
7. Contract Item 2G (Contingent Contract Item): Replacement of 4 inches service duct if required and authorized by Owner, unit price per linear foot of duct.

- a. If during the Work, it is found that additional work is required to replace portion of the 4 inches service duct and the work is authorized in writing by the Owner, the cost for service duct replacement shall be paid for by the unit price per linear feet listed on the Bid Form.

8. Contract Item 2H (Bid Allowance): 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, labor burden rate, and the resulting billable rates for straight and overtime work.
 - 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. Documentation including certified payrolls may be required to validate the rates.
 - 3. Payment for Extra Work will be based on the rates that are validated and approved by the Owner.

1.04 CHANGE ORDERS

- A. Initiation: Change Order Proposal
 - 1. The Owner or the Engineer may issue a Request for Change Order Proposal (RCP). The RCP 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. The Contractor shall submit a Proposed Change Order (PCO) in response to the Owner's RCP as required by contract requirements. The PCO shall include detailed cost breakdown of labor, material, and equipment, and applicable contract mark-ups. The PCO must also include any time extension request with detailed supporting documentation.
 - 3. By submittal of a Proposed Change Order hereunder, the Contractor certifies and agrees as follows:
 - a. He has carefully reviewed and evaluated the proposed change to the Work; and

- b. The information set forth in the Proposed Change Order is accurate and complete, to the best of his knowledge and belief.

B. Execution of Change Order:

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.

Failure to submit a bona fide proposal within the time required shall be deemed to constitute the Contractor's agreement to the Engineer's estimated adjustments, if any, to the Contract Sum or Contract Period for the Work pertaining to the Proposal.

2. The Contractor shall explain the proposal in as much detail as requested by the Owner.
3. Any decrease in Contract Sum on account of omitted Work will 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 or if a Work Order has been 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, crew foreman or general foreman performing or directly supervising the Work on the Site.
2. Labor Burden: Net premium for Workman's Compensation Insurance, taxes pursuant to the Federal Social Security Act, payments required under State and Federal unemployment laws.
3. Additional Materials: Necessary extra materials, delivered at the site including the actual cost of consumable supplies. Consumable supplies shall not be determined by the percentage of cost basis.
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 for contractor owned equipment in the current "Rental Rate Blue Book" service provided by Equipment Watch.
5. Subcontractor Costs: Subcontractor's costs including subtier contractors shall be determined by items 1 through 4 in the immediately preceding subparagraphs, including a maximum profit and overhead of 20 percent regardless of the number of subtier subcontractors.

6. Overhead and Profit:
 - a. Plus a maximum of 20 percent, for overhead and profit, of items 1 through 4 above.
Plus a maximum of 10 percent for overhead and profit of item 5.
7. During periods of unreasonable downtime caused or required by the Owner, 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. The rates for overhead and profit will be 10 percent.
 - d. No compensation for equipment overhaul, field repair and fuel expenses shall be included.

1.05 CORRELATION WITH CONTRACTOR'S SUBMITTALS

- A. Revise Schedule of Values and Application for Payment forms to record each change as a separate item of Work and to record the adjusted Contract Price.
- B. Revise the Construction Schedule monthly to reflect each change in Contract Time.
 1. Revise subschedules to show changes for other items of work affected by the changes.
- C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

1.06 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

NO TEXT ON THIS PAGE

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. Electronic Access Request and Authorization Form

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

H. 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.

I. Plant Impact Request

J. Maintenance Summary Form

K. Spare Parts and Maintenance Material Transmittal

L. Equipment and Systems Owner Instruction Form

M. Contractor's Notice of Beneficial Use

N. Contractor's Certificate of Final Completion

O. Consent of Surety to Final Payment

P. Final Payment Affidavit and Release of Claims

END OF SECTION



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____
PROJECT NAME: POPES HEAD PUMPING 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

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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPES HEAD PUMPING 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)

____ Construction Department
____ [Contractor]

____ Consultant

FORM CM/7

REV.01/16

Contract No. _____
Project P2722 Division 003

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)

____ Construction Department
____ [Contractor]

____ Consultant

FORM CM/7

REV.01/16



PLANNING AND ENGINEERING DIVISION
 FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO.
 PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION
FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO.
PROJECT NAME: POPES HEAD PUMPING 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
☐ CONTRACTOR
☐ OTHER



PAYMENT BREAKDOWN

[illegible]

____ **Manager, Construction**
[Contractor]

ADMIN\FORMS\PAYMNT BRKDWN.DOC

APPLICATION AND CERTIFICATE FOR PAYMENT No.



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO.

PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPES HEAD PUMPING 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



Planning and Engineering Division

PROPOSED CHANGE ORDER

PROJECT: POPES HEAD PUMPING STATION ELECTRICAL UPGRADES

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

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

PROJECT NO.: P2722 , **Division** 003

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: _____



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____PROJECT NAME: POPE'S HEAD PUMPING 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: _____

DISTRIBUTION: (Please check)

_____ **Manager, Construction**

_____ **Other** _____

FORM CM/12



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPES HEAD PUMPING 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.

[illegible]

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) ☐ 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:_____		Days of Week Access is Needed (check all that apply) ☐ 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)



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPE'S HEAD PUMPING STATION ELECTRICAL UPGRADES

Contractor's Electronic Access and Cyber Key Log

Prepared By: _____ Date Submitted: _____

[illegible]



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____PROJECT NAME: POPES HEAD PUMPING STATION ELECTRICAL UPGRADES

PLANT IMPACT REQUEST

Project Information

Project Name:

Date Submitted:

Contractor Contact:

Phone #:

Impact Overview

No.:

Revision:

References

Title:

Drawings:

Specs.:

Purpose:

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

Description of activity:

Description of impact to facility:

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 hereby 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				

PROJECT NAME: POPE'S HEAD PUMPING STATION ELECTRICAL UPGRADES

[illegible]

9. LUBRICANT LIST

[illegible]

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:



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____

PROJECT NAME: POPES HEAD PUMPING 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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. PROJECT NAME: POPES HEAD PUMPING 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



CONTRACTOR'S CERTIFICATE OF FINAL COMPLETION

REV. 02/17



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

CONTRACT DATE:

SURETY COMPANY,

_____, 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



PLANNING AND ENGINEERING DIVISION

FCWA PROJECT # P2722 DIVISION 003 CONTRACT NO. _____PROJECT NAME: POPES HEAD PUMPING 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 01250: Contract Modification Procedures.
- D. Section 01320: Construction Schedule.
- E. Section 01720: Field Engineering and Surveying.
- F. Section 01770: Contract Closeout.
- G. 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. Provide construction photographs in accordance with Section 01330
- C. 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 provide, as a prerequisite for monthly progress payments, an accumulating cost curve (tabular and diagram), indicating schedule, forecast and actual progress.

F. 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

NO TEXT ON THIS PAGE

SECTION 01310
PROJECT MEETINGS

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Preconstruction Conference
- B. Progress Meetings
- C. Pre-Installation and Pre-Demolition Conferences

1.02 REFERENCES

- A. NOT USED

1.03 PRECONSTRUCTION MEETINGS

- A. General: Prior to the commencement of Work at the Site, a 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
3. 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.
- C. Preconstruction Survey: Before any Work is performed at the site by the Contractor, a joint preconstruction survey will be performed. The Contractor, Engineer and Owner will review the existing conditions jointly and record via video and digital photos this review. The Contractor shall be responsible for procuring the services of a professional photographer and for scheduling the preconstruction survey; however, the survey date(s) shall be coordinated with the Owner. When the survey is completed, the Owner shall be provided with the original CD/DVD 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.

1.05 PRE-INSTALLATION AND PRE-DEMOLITION CONFERENCES

- A. Conduct conferences at the Project site before the start of each construction activity as specified in the Specifications or otherwise directed by the Owner.
- B. Attendees: Subcontractors, installers and representatives of manufacturers involved with or affected by the installations shall attend the meeting. The Contractor shall advise the Owner/Engineer of scheduled meeting dates.
- C. Agenda: Review progress of construction activities and preparations for the particular activity, including requirements for the following:
 - 1. The applicable contract document requirements.
 - 2. Related RFCs / Change Orders
 - 3. Purchases / Deliveries
 - 4. Submittals / Review of mockups
 - 5. Possible conflicts (space, access, compatibility issues)

6. Time schedules
7. Temporary facilities and controls
8. Inspections/Quality control
9. Safety (Protection of construction, equipment, and personnel)
10. Installation procedure(s)
11. Coordination with other work

D. The Contractor is to keep a written record of each meeting and produce/distribute minutes recording discussions and agreements for items above to all attendees.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION 01310

NO TEXT ON THIS PAGE

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.

J. 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.

K. 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.
- L. 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

Not Used

END OF SECTION 01320

NO TEXT ON THIS PAGE

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.
- C. When submitted in electronic format, the documents shall be searchable PDF. Scanned or photocopies are not acceptable.

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.

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, submittals required by the

Fairfax County Special Inspections Program, 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. Contractor shall submit to Engineer three additional copies of all drawings and data necessary to meet the requirements of the Fairfax County Special Inspections Program if applicable, as described herein. 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. 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. Where submittals are required by the Fairfax County Special Inspections Program; 3 additional hard copies may be required of the approved submittals in accordance with paragraph 1.07.D.
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 003300 008 B

D = Shop Drawing

003300 = 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.

D. Submittals Required by Fairfax County or other localities' Special Inspections Program

1. The Contractor shall submit three additional sets of drawings and data for the following items (if applicable) to satisfy the submission and approval requirements of the Fairfax County Special Inspections document:

Structural steel

Cast in place concrete

Precast concrete

Masonry

Soils and foundations

Earth retention systems

2. The Engineer will review, approve, and stamp these submittals in accordance with the Special Inspections Document and return them to the Contractor. After these submittals have been approved by the Engineer, the Contractor shall submit the three copies to the Fairfax County Special Inspections Section of the Commercial Inspections Branch, Division of Inspection Services, Department of Environmental Management. Following County review and approval, the Contractor shall pick up the documents from the County office and deliver one approved copy to the Engineer. The contractor shall keep one approved copy on site with the Record Documents. The Contractor shall be responsible for the submittal and return of all shop drawings required by the Fairfax County or other localities' Special Inspections Program.

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.

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.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION 01330

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
Popes Head Pumping Station Electrical Upgrades – FW Project 2722, Division 003.

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

NO TEXT ON THIS PAGE

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
- E. Fairfax County Special Inspections Manual
- 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.
- E. Fairfax County Special Inspections Program: The Contractor shall abide by the requirements of the Fairfax County Special Inspections Program. The term "General Contractor" used therein shall mean the Contractor as defined in the General Conditions of the Contract Documents.

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
- 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.
- E. The Contractor is responsible for providing a Responsible Land Disturber for this Work. The letter of transmittal (to be used by the Owner) and the Responsible Land Disturber Certification form (to be used by the Contractor) are included in the Appendix of the Specification. The Contractor must provide the completed Responsible Land Disturber Certification form to the Owner before commencement of work but in no case later than 20 days after Notice to Proceed. Failure to submit this certification will result in withholding of progress payments. The Owner will complete the transmittal letter and send the completed form to Fairfax County.
- F. Noise Variance: The Contractor is responsible for obtaining this in accordance with Section 01500.
- G. Trade Permits: The Contractor shall be responsible for obtaining his own trade permits.
- H. 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

NO TEXT ON THIS PAGE

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

NO TEXT ON THIS PAGE

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 02316 Earthwork

1.03 GENERAL REQUIREMENTS

- A. Furnish plan 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, pumps, 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 regulations, 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. **Water:** Any water required for testing by the Contractor will be provided at the Owner's standard rates for the additional volume required. The Contractor shall, if necessary, provide and lay water lines to the place of use; secure all necessary permits and pay for all taps to water mains and hydrants.
- B. **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.
- C. **Pump Station Control Panel Power:** The pump station control panel shall not be permitted to be taken of service during construction. The Contractor shall provide temporary power to the pump station's control panel, when permanent utility power is not available.
- D. **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.
- E. **Sanitary Facilities:** 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.
- F. **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.

F. 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. 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.
7. 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.
8. 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.
9. 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 108 during 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, if necessary, 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 will be required to erect, furnish, and maintain a field office, with a telephone, during the entire period of construction. Readily accessible copies of both the Contract Documents and the latest approved shop drawings shall be kept at this field office. The Contractor shall be responsible for obtaining a site for his offices and locations of storage materials, at no additional cost to The Owner. The Contractor shall be responsible for the selection and authorization, in writing, of the field office site. The size and location of the field office shall require The Owner's approval.

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

1.01 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 or 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.

1.02 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.

1.03 ELECTRICAL AND CONTROL WIRING IDENTIFICATION

- A. Provide wiring types, color coding, and other identification requirements as specified in Section 16075, Identification for Electrical Systems.

1.04 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.

1.05 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.

1.06 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.

1.07 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.

1.08 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

General Information													SAP Information					Basic Name Plate Info										Warranty	
Equipment No.	Project/Subdivision	Equip Type	Description	Drawings	Std Facility ID	Acquisition Date	Acquisition Value	Start-up Date	VLOC or Superior Equipment	Settlement Order	Cost Center	Work Center	SAP Catalog	SAP BOM #	ABC Indicator	Manufacturer	Model	Serial No	Part No	Country Manufactured	Year Manufactured	Month Manufactured	Weight	Unit	Size/Dimension	Start Date	End Date		
00000000	03800-000	TRF	3000 GVA Value 2	00000000	00000000	1/1/2015	300.00	3/1/2015	FW-30-30-PWH-VSW-SCS-000	2030	729-01	729-01	Electrical Main Griffln	00000000	312	00000000	00000000	00000000	00000000	US	2015	01	200.00	60" X 72"	3/1/2015	12/2015			
00000000	00000000	TRF	Transformer	00000000	00000000	1/1/2015	300.00	3/1/2015	FW-30-30-PWH-BUL-TM	729-01	729-01	Electrical Main Griffln	00000000	00000000	00000000	00000000	00000000	00000000	00000000	US	2015	01	200.00	60" X 72"	3/1/2015	12/2015			
00000000	00000000	TRF	Transformer	00000000	00000000	1/1/2015	300.00	3/1/2015	FW-30-30-PWH-BUL-TM	729-01	729-01	Electrical Main Griffln	00000000	00000000	00000000	00000000	00000000	00000000	00000000	US	2015	01	200.00	60" X 72"	3/1/2015	12/2015			
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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
- B. Section 01330 Submittals

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 approved 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 approved equal", no substitutions will be allowed.
 - 3. Where only one manufacturer is listed, equivalent products from other manufacturers will be considered "or equal," unless specified otherwise.

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 un contemplated 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

NO TEXT ON THIS PAGE

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. Submittal Requirements are included in Section 01330.
- D. Applications for Payment are included in Section 01290.
- E. 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 items 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

NO TEXT ON THIS PAGE

SECTION 01730

CUTTING AND PATCHING

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Requirements and limitations for cutting and patching of Work.

1.02 GENERAL REQUIREMENTS

- A. Coordinating Work: The Contractor shall do all cutting, fitting or patching of the Work that may be required to make several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Contract Documents. The restoration shall be performed by competent workmen skilled in the trade.
- B. Correction of Defective Work: The Contractor shall perform all cutting and patching required for the Work, as may be necessary in connection with uncovering Work for inspection or for correcting defective work.
- C. Improperly Timed Work: The Contractor shall perform all cutting and patching required to install improperly timed Work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or for the installation of new Work in the existing construction.
- D. Limitations: Except when the cutting or removal of existing construction is specified or indicated, Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without the Engineer's concurrence.

1.03 SCHEDULING

- A. Connections with Existing Facilities: The Contractor is advised that if any connections, replacement, and other Work requiring the shutdown of an existing facility are necessary, these shutdowns can only be scheduled when the impact on the Owner's normal operation is minimal and in accordance with the Drawings and Section 01140 at no additional cost to the Owner. The Contractor may be required to work overtime, nights and weekends in making these connections, especially if the connections are made at times other than those specified. When a shutdown of an existing facility is necessary, the contractor shall complete the tie-in in as expeditious manner as possible, minimizing the down time of the existing facility. Once an existing facility is shut down, the contractor shall work continuously on the tie-in until the new facility has been placed back into service. No shut downs which result in customers being out of service will be permitted on Mondays, Fridays, Thanksgiving week, or Christmas week.
- B. The Owner and the Engineer must be notified at least 10 days in advance of any shutdown required as a result of the Contractor's Work. A detailed plan for any shut-down and tie-in is required to be submitted under Section 01140 for review at least 28 days in advance of such shut-down and/or tie-in. Shutdowns shall be shown on the project schedule submitted by the Contractor.
- C. All shutdowns shall be incorporated into the Contractor's Schedule in accordance with the provisions of Section 01320 and schedule requirements noted within the Contract Drawings.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 PREPARATION

- A. Shoring Bracing: The Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work and existing facilities during cutting and patching operations.
- B. Removal of Existing Materials: Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work at no additional cost. Materials shall be removed in a careful manner with no damage to adjacent facilities or materials. Materials which are not salvageable shall be removed from the site by the Contractor.

3.02 RESTORATION

- A. Restoration of Existing Facilities: All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to the Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

END OF SECTION 01730

SECTION 01751

STARTING AND PLACING EQUIPMENT IN OPERATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall initially start up and place equipment and systems installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
2. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
3. Provide chemicals, lubricants, and other required operating fluids.
4. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.
5. General activities by CONTRACTOR include the following:
 - a. Cleaning, as required under other provisions of the Contract Documents.
 - b. Removing temporary protective coatings.
 - c. Flushing and replacing lubricants, where required by manufacturer.
 - d. Lubrication.
 - e. Checking shaft and coupling alignments and resetting where required.
 - f. Checking and setting motor, pump, and other equipment rotation, safety interlocks, and belt tensions.
 - g. Checking and correcting (as necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
 - h. Performing all adjustments required.

B. Coordination:

1. Coordinate checkout and start-up with other contractors, as necessary.
2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
3. OWNER will furnish sufficient personnel to assist CONTRACTOR in starting up equipment, but responsibility for proper operation is CONTRACTOR's.

4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to ENGINEER.
5. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by CONTRAC-TOR in accordance with Section 01782, Operation and Maintenance Data.

C. OWNER's Assumption of Responsibility for Equipment and Systems:

1. OWNER will assume responsibility for the equipment upon Certification of Beneficial Use, unless otherwise mutually agreed upon by OWNER and CONTRACTOR or as documented in the certificate of Beneficial Use.
2. Before turning over to OWNER responsibility for operating and maintaining system or equipment CONTRACTOR shall:
 - a. Provide training of operations and maintenance personnel in accordance with Section 01800, Equipment and System Training.
 - b. Complete performance of equipment and system field quality control testing in accordance with the Contract Documents, to the extent possible.
 - c. Submit acceptable final operations and maintenance manuals in accordance with Section 01782, Operation and Maintenance Data.
 - d. Obtain from ENGINEER final certificate of Beneficial Use for either entire Work or the portion being turned over to OWNER.

1.02 SUBMITTALS

A. Closeout Submittals: Submit the following:

1. Certifications:
 - a. Supplier's certification of installation in accordance with Paragraph 3.1.B of this Section.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 SERVICES OF SUPPLIER

- A. When specified, furnish services of competent, qualified representatives of material and equipment manufacturers, including supervising installation, adjusting, checkout, startup, and testing of materials and equipment.

B. Certification:

1. When services by Supplier are required at the Site, within 14 days after first test operation of equipment, submit to ENGINEER a letter from Supplier, on Supplier's letterhead, stating

that materials and equipment are installed in accordance with Supplier's requirements and installation instructions, and in accordance with the Contract Documents.

2. In lieu of Supplier letter, submit completed form attached to this Section.
3. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.

3.02 MINIMUM STARTUP REQUIREMENTS

A. Bearings and Shafting:

1. Inspect for cleanliness, and clean and remove foreign matter.
2. Verify alignment.
3. Replace defective bearings and those that operate in a rough or noisy manner.
4. Grease as necessary, in accordance with manufacturer's recommendations.

B. Drives:

1. Adjust tension in V-belt drives and adjust vari-pitch sheaves and drives for proper equipment speed.
2. Adjust drives for alignment of sheaves and V-belts.
3. Clean and remove foreign matter before starting operation.

C. Motors:

1. Check each motor for comparison to amperage nameplate value.
2. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.

D. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.

E. Open steam traps and air vents, where used, and remove operating elements. Clean thoroughly, replace internal parts, and place back into operation.

F. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.

G. Set and calibrate draft gauges of air filters and other equipment.

H. Check each electrical control circuit to verify that operation complies with the Contract Documents.

I. Inspect each pressure gauge and other instruments for calibration. Replace items that are defaced, broken, or that read incorrectly.

J. Repair damaged insulation.

K. Excess Gasses and Fluids:

1. Vent gasses trapped in systems.
2. Verify that liquids are drained from all parts of air systems.

3.03 ATTACHMENTS

A. The attachment listed below, following this Section's "End of Section" designation, is a part of this Specification Section.

1. Supplier's Installation Certification Form (one page).

END OF SECTION 01751

SUPPLIER'S INSTALLATION CERTIFICATION

Contract No. and Name: _____

Equipment Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment: _____

The undersigned Supplier of the equipment or system described above hereby certifies that Supplier has checked the installation of the equipment or system and that the equipment or system, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations and the Contract Documents, and that the trial operation of the equipment or system has been satisfactory.

Comments: _____

Date

Supplier Name (print)

Signature of Supplier

Date

Contractor Name (print)

Signature of Contractor

NO TEXT ON THIS PAGE

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. Submittals and electronic document formatting shall be in accordance with Section 01330, Submittals.
- B. 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.
- C. 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.
- D. 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.
- E. Equipment Index: Equipment Index shall be submitted 30 days prior to Beneficial Use in accordance with Section 01615.
- F. 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

NO TEXT ON THIS PAGE

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 SUBMITTALS

- 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.
- B. Submittals and electronic document formatting shall be in accordance with Section 01330, Submittals.

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.
 - 1. 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.
 - 2. When changes are required on small-scale drawing details, use large-scale inserts with leaders to the applicable location.
 - 3. 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 sets 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.
- C. 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, 2 hard copies and one electronic copy of the O&M Manual shall be submitted for use during construction. The electronic manuals shall be provided in the latest searchable Adobe Acrobat electronic portable document format (PDF), scanned or photocopies are not acceptable, and be viewable and searchable (where possible) on CD-ROM.

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.

1.05 CONTENTS OF OPERATIONS AND MAINTENANCE MANUALS

- A. This section describes the required content of the Operations and Maintenance Manuals.
- B. The O&Ms shall include all general instructions, a description of the equipment and how it functions, and shall provide all information necessary for identification and normal operation.

- C. Include the equipment pre-startup, startup, and normal operating instructions. Include the sequence of operation by the controls manufacturer. Also, include the shutdown and emergency shutdown instructions.
- D. Include general assembly drawings, sections, and photographic views as necessary to completely depict and properly identify the equipment. The material provided shall indicate the dimensions, weight, capacity and design conditions for the equipment.
- E. Include detailed information, drawings, procedures and guides to allow for the proper installation, calibration, testing, PM and CM maintenance procedures.
- F. Include all the drawings or schematics necessary to properly assemble and install the equipment including alignment, clearances, tolerances and interfacing equipment requirements. Denote by trade the skill level required to install the equipment, any special rigging required to place the equipment in place, and any special test equipment required to place the equipment in service.
- G. Include all safety and tag-out procedures necessary to safely operate and maintain the equipment. Address all lubrication points, reservoirs or locations.
- H. Include statistical information from the original equipment manufacturer as to performance such as pump curves, flow charts, insulation resistance, calibration, or test data sheets, etc. Include actual operational startup and testing procedures and data obtained, recorded and submitted denoting test method, test equipment used and the procedure used. The Contractor shall submit startup and testing forms for the Engineer's approval.
- I. Include preventive maintenance (PM) requirements for equipment inspection, testing, routine adjustments and lubrication to address work at the component level (e.g., motor, drive, gearbox, etc.); the frequency that work is to be performed; drawing(s) references; and service manual references.
- J. PM requirements shall encompass all levels of effort ranging from daily/weekly inspections performed by operations personnel through routine PMs scheduled weekly, monthly, quarterly, semi-annually or annually through major overhauls by maintenance personnel. Include predictive maintenance work which will include testing analysis of the equipment such as vibration, flow, oil sampling, meggering, alignment, lubrication, etc.
- K. For corrective maintenance procedures, all equipment shall be detailed for complete disassembly and assembly, and shall be covered by cross-sectional drawings or exploded views with all parts numbered to correspond with the numbers in the parts list to permit identification of the various parts. Normal clearances, diameters, thicknesses of new parts and limits permissible for wearing parts shall be included. Torque settings for nuts, bolt and fasteners shall be provided as required.
- L. Provide a complete list of parts (with a cross-reference to other manufacturers) or suppliers(s) of the same type of interchangeable component or product included along with their part numbers. The parts list shall be complete, and described so that parts may be readily identified and ordered. Each part shall be identified by the manufacturer's part number and cross referenced to the OEM part number (i.e., SKF bearing #63052/manufacturer's #B-K-1905F.)
- M. Recommend spare parts listing and frequency of replacement for all wearing components. Include part numbers, frequency of replacement on a running time, calendar and/or seasonal basis as applicable and annotate with the manufacturer's anticipated useful life expectancy of the unit expressed in running time and calendar years. A listing of gaskets or any other items which may be required to perform a complete and satisfactory replacement and/or overhaul shall be included with the replacement parts list.

- N. The minimum and maximum stock level requirements for spare parts should be quantified. Identify recommended emergency reserve parts, components, and whole equipment units and their extended cost.
- O. All internal test points and maintenance checks of each piece of equipment and/or device shall be shown on drawings and diagrams, and referenced to the maintenance and testing procedures.
- P. Include all necessary diagrammatic piping and wiring diagrams and miscellaneous necessary drawings and equipment. Lettering shall be typed or printed; hand lettering is not acceptable.
- Q. Include all of the Contractor's and/or manufacturer's warranty information. This shall include effective warranty dates.
- R. For all service manuals submitted for field assembled equipment such as electrical systems (e.g., MCCs, switchgear and control panels) and control instrumentation, as-built drawings shall be submitted by the Contractor whenever the equipment as finally installed differs from the manner in which it was depicted in the earlier submittals. These drawings shall be in the same format as the original submittals and shall be suitable for insertion into the service manuals as replacement drawings.
- S. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by Contractor for installation purposes.
- T. Shipment of equipment will not be considered complete until all required manuals and data have been received.

1.06 ELECTRONIC DOCUMENT PROGRAM DOCUMENTATION.

- A. Contractor shall provide electronic document program documentation that includes the following:
 - 1. Define file-naming convention.
 - 2. Identifies vendor point of contact and telephone and fax numbers, and e-mail address.
 - 3. There shall be no passwords or security settings applied by Contractor.

1.07 WARRANTY

- A. The Contractor shall provide a twelve-month warranty on all electronic documents that covers the following items:
 - 1. Contractor shall agree to replace any portion of the electronic document that does not view or print to the Owner's satisfaction.
 - 2. Contractor shall agree to file re-sizing in the event the Engineer deems document access unsatisfactory.
 - 3. Contractor shall agree to provide the electronic document for any missing reference materials.]

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 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 following training shall be provided to the mechanical, electrical, or instrumentation maintenance personnel; the lesson plan shall be delivered one time for each specific trade material.
 - 1. Single Breaker Generator Docking Station (Section 16266) – 4 hours.
 - 2. Medium-Voltage Fusible Interrupter Switches (Section 16310) – Combine with Section 16341.
 - 3. Medium-Voltage Metal Enclosed Switchgear (Section 16341) – 8 hours.
 - 4. Medium-Voltage Motor Starters (Section 16349) – 8 hours.
- 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

NO TEXT ON THIS PAGE

SECTION 02220

DEMOLITION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required for demolition, removal, and disposal Work.
2. The Work under this Section includes, but is not necessarily limited to:
 - a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of electrical systems and equipment, concrete equipment pads, partial masonry wall, hollow metal door, metals, masonry, attachments, duct bank, conduit, conductors, and sidewalk.
 - b. Demolition and removal of all Underground Facilities underneath, and above-grade piping and utilities in, the building and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
 - c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
3. Demolitions and removals specified under other Sections shall comply with requirements of this Section.
4. Perform demolition Work within areas shown or indicated.
5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition.

B. Coordination:

1. Comply with Section 01140, Limitation on Sequence of Construction.
2. Review procedures under this and other Sections and coordinate the Work that will be performed with or before demolition and removals.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 01730, Cutting and Patching.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.

B. Regulatory Requirements:

1. Demolition, removal, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T - Demolition), and all other Laws and Regulations.
2. Comply with requirements of authorities having jurisdiction.

1.03 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Procedure Submittals:
 - a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
 - 1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
 - 2) Other proposed procedures as applicable.
 - 3) Equipment proposed for use in demolition operations.
 - 4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
 - 5) Planned demolition operating sequences.
 - 6) Detailed schedule of demolition Work in accordance with the accepted Process Schedule.
2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.01.A of this section.
3. Qualifications Statements:
 - a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 PREPARATION

A. Notification:

1. At least 48 hours prior to commencing demolition or removal, notify ENGINEER in writing of planned start of demolition Work. Do not start removals without permission of OWNER.

B. Protection of Surrounding Areas and Facilities:

1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties.
 2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
 3. Provide temporary barriers, lighting, sidewalk sheds, and other necessary protection.
 4. Repair damage to facilities that are to remain.
- C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, do the following:
1. Should uncharted or incorrectly charted Underground Facilities be encountered, CONTRACTOR responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
 2. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
 3. Shutdown of utility services shall be coordinated by CONTRACTOR, assisted by OWNER as required relative to contacting utility owners.

3.02 DEMOLITION – GENERAL

- A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.
- B. Pollution Controls:
1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Laws and Regulations.
 2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
 3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions.
- C. Explosives:
1. Do not bring explosives to the Site. The use of explosives onsite is strictly prohibited.
- D. Comply with Section 01730, Cutting and Patching.
- E. Building or Structure Demolition:
1. Unless otherwise approved by ENGINEER, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.

2. Demolish concrete and masonry in small sections.
3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
4. Break up and remove foundations and slabs-on-grade unless otherwise shown or indicated as remaining in place.

F. Demolition of Site Improvements:

1. Sidewalks and pavement: Demolition of asphalt or concrete pavement and sidewalks, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
2. Underground Facilities: Remove to the extent shown or indicated on the Drawings. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Section.

G. Salvage and Ownership:

1. CONTRACTOR shall remove the items listed herein and turnover (salvage) to the OWNER upon removal.
 - a. Medium Voltage Contactors (trucks).
 - b. 4160V CPT
 - c. 4160V Control Board
2. Materials and equipment to remain OWNER's property shall be carefully removed and appropriately handled by CONTRACTOR to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site (or other site specified in the Contract Documents) at place designated by ENGINEER or OWNER.

H. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by ENGINEER.

3.03 STRUCTURAL REMOVALS

- A. Remove structures to lines and grades shown or indicated, unless otherwise directed by ENGINEER. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at CONTRACTOR's expense and such excess removals shall be reconstructed to satisfaction of ENGINEER without additional cost to OWNER.
- B. Recycling and Reuse of Demolition Materials:
1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by ENGINEER.
 2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

- C. After removing concrete and masonry walls or portions thereof, slabs, and similar construction that ties into the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.
- D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
 - 1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
 - 2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
 - 3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
 - 4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.
- E. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, remove the anchors to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by ENGINEER.
- F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.
- G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Section, unless specified elsewhere in the Contract Documents.

3.04 ELECTRICAL REMOVALS

- A. Electrical demolition Work includes removing existing transformers, distribution switchboards, control panels, motors, starters, conduit and raceways, cabling, panelboards, switches, duct banks, conduits, conductors, and miscellaneous electrical equipment, as shown, specified, or required.
- B. Remove existing electrical equipment and fixtures to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
- C. Remove or modify motor control centers and switchgear as shown or indicated. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.
- D. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated. Motors, microprocessors and electronics, other electrical gear to be reused shall be stored in accordance with Section 01600, Materials and Equipment.

- E. Cables in conduits to be removed shall be removed back to the power source or control panel, unless otherwise shown or indicated. Verify the function of each cable before disconnecting and removing.
- F. Conduits, raceways, and cabling shall be removed where shown or indicated. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to ENGINEER. Exposed conduits, junction boxes, other electrical appurtenances, and their supports shall be disassembled and removed. Repair all areas of the Work to prevent rusting on exposed surfaces.
- G. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
- H. Where shown or indicated, remove direct burial cable. Openings in buildings for entrance of direct burial cable shall be patched with repair mortar or other material approved by ENGINEER for this purpose, and made watertight.
- I. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as OWNER's property, shall be removed and properly disposed off-Site as required.

3.05 DISPOSAL OF DEMOLITION DEBRIS

- A. Remove from the Site all debris, waste, rubbish, and material resulting from demolition operations and equipment used in demolition Work. Comply with the General Conditions and Supplementary Conditions.
- B. Transportation and Disposal:
 - 1. Non-hazardous Material: Properly transport and dispose of non-hazardous demolition debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, PCBs, Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.
 - 2. Hazardous Material: When handling and disposal of hazardous materials is included in the Work, properly transport and dispose of hazardous materials in accordance with the Contract Documents and Laws and Regulations.
- C. Submit to ENGINEER information required in this Section on proposed facility(ies) where demolition material will be recycled. Upon request, ENGINEER or OWNER, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist ENGINEER and OWNER.

END OF SECTION 02220

SECTION 02316

EARTHWORK

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
2. Preparation of subgrade for slabs and pavements is included under this Section.
3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 03005, Concrete.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/AISC 360, Specification for Structural Steel for Buildings.
2. ASTM D422, Test Method for Particle-Size Analysis of Soils.
3. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
4. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
5. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
6. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
7. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
8. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
9. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

10. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
11. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.03 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 1. Contractor's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
 - b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
 - c. Testing laboratory shall be experienced in the types of testing required.
 - d. Selection of testing laboratory is subject to Engineer's acceptance.
- B. Quality Assurance Testing:
 1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
 2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at Owner's expense, including retesting of rejected materials and installed Work, shall be performed at Contractor's expense.
 3. Contractor's Testing Laboratory Scope:
 - a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
 - b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
 - c. Submit to Engineer and Contractor written report results of each test.
 4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:
 - a. Gradation in accordance with ASTM D422. Perform one test for every 10 cubic yards of each material incorporated into the Work.

- b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 10 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
- c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 10 cubic yards of each material incorporated into the Work.
- d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 10 cubic yards of each material incorporated into the Work.

C. Regulatory Requirements:

- 1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
 - a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
- 2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.05 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Modifications to the Work proposed due to intended excavation plan.

B. Informational Submittals: Submit the following:

- 1. Procedure Submittals:
 - a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
 - 1) Name of Contractor's "competent person" in responsible charge of excavation and fill Work.
 - 2) Excavation method(s).
 - 3) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
 - b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
- 2. Quality Assurance Test Results Submittals:
 - a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:

- 1) Tests on borrow fill material.
- 2) Optimum moisture – maximum dry density curve for each type of fill material.
3. Field Quality Control Submittals:
 - a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
 - 1) Field density testing.
4. Qualifications Statements:
 - a. Field Quality Control Testing Laboratory: Names and qualifications of testing laboratory employed, and qualifications of testing laboratory's personnel that will perform field quality control testing as required under this Section.

1.06 SITE CONDITIONS

- A. Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Owner. Coordinate Contractor-performed test borings and other exploratory operations with Owner and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of Owner or utility owners. Comply with Laws and Regulations relative to required notifications.
- B. Existing Structures:
 1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by Contractor. Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Owner.
 2. Movement or operation of construction equipment over Underground Facilities shall be at Contractor's sole risk and only after Contractor has prepared and submitted to Engineer and utility owners (as applicable), and received acceptance therefrom, a plan describing Contractor's analysis of the loads to be imparted and Contractor's proposed measures to protect structures and Underground Facilities during the Project.
 3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, Owner will assist Contractor with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
 4. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by Engineer after acceptable temporary utility services are provided by Contractor for the affected structure or property.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Select Fill:

1. Material shall be well-graded, crushed aggregate, free of organic material, complying with the following:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
1.25-inch	100
No. 4	38 to 65
No. 8	25 to 60
No. 30	10 to 40
No. 200	3 to 12

B. General Fill:

1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain Engineer's approval of the material proposed for use.

C. Subbase Material:

1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand, complying with the gradation requirements below. Crushed slag is unacceptable.

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve
2-inch	100
1-inch	70 to 100
3/4-inch	50 to 90
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 15

D. Drainage Fill:

1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

2.02 SOURCE QUALITY CONTROL

- A. Perform quality assurance testing, and submit results to Engineer, in accordance with the 'Quality Assurance' Article in Part 1 of this Section.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Provide Engineer with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. Engineer will advise Contractor in writing when Engineer is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 TEST PITS

- A. General:
 - 1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. Contractor shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. Contractor shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.
- B. Payment for Test Pits:
 - 1. Separate payment will not be made for test pits made by Contractor for Contractor's own use.

3.03 PREPARATION

- A. Site Preparation:
 - 1. Clear areas to be occupied by permanent construction of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip vegetation, sod, topsoil, and organic matter from subgrades where fills will be placed, and from areas where structures will be constructed. Remove from the Site and properly dispose of all waste materials.
 - 2. Burning is not allowed at the Site.
- B. Use of Explosives:
 - 1. Use of explosives is not allowed.
- C. Dust Control:
 - 1. Control objectionable dust caused by Contractor's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to Engineer's acceptance and approval of authorities having jurisdiction.
- D. Maintenance and Protection of Traffic:
 - 1. Keep all streets and traffic ways open for passage of traffic and pedestrians during the Project, unless otherwise approved by owner of the street, traffic way, or right-of-way, as applicable. Construction traffic shall access the Site only via the entrance from Popes Head Road.
 - 2. When required to cross, obstruct, or temporarily close a street or traffic way, provide and maintain suitable bridges, detours, and other acceptable temporary expedients to accommodate traffic. Closings of street or traffic way shall be for shortest time practical,

and passage shall be restored immediately after completion of fill and temporary paving or bridging.

3. Give required advance notice to fire department, police department, and other emergency services as applicable of proposed construction operations.
4. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 14 (fourteen) days prior to construction that will affect the property.
5. Hydrants, valves, fire alarm boxes, postal boxes and delivery service boxes, and other facilities that may require access during construction shall be kept accessible for use.
6. Provide temporary signage, signals, barricades, flares, lights and other equipment, service, and personnel required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions, as applicable.

3.04 DEWATERING

A. Dewatering – General:

1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the structure to be built therein is acceptable to Engineer and backfilling operations are completed and acceptable to Engineer.
2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
4. Contractor shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
5. Remove water from excavations as fast as water collects.

B. Disposal of Water Removed by Dewatering System:

1. Contractor's dewatering system shall discharge to a suitable location acceptable to OWNER, in accordance with Laws and Regulations.
2. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
3. Dispose of water in manner that causes no inconvenience to Owner, others involved in the Project, and adjacent and downstream properties.

3.05 EXCAVATION

- A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.
- B. Excavation Protection:
 - 1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
 - 2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
 - 3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
- C. Maintain excavations in dry condition in accordance with "Dewatering" Article in Part 3 of this Section.
- D. Elevation of bottom of footings shown is approximate. Engineer may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.
- E. When excavations are made below required grades without written order of Engineer, fill such excavations with compacted select fill, as directed by Engineer, at Contractor's expense.
- F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of excavation supports, and the safe sloping of banks, as necessary.
- G. Subgrades – General:
 - 1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with approved subgrade material per Section 2.01.C. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
 - 2. If, in Engineer's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within Contractor's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at Contractor's expense.

3.06 UNAUTHORIZED EXCAVATION

- A. All excavations outside lines and grades shown or indicated and that are not approved by Engineer, together with removing and disposing of the associated material, shall be at Contractor's expense. Fill unauthorized excavations with properly-compacted select fill material at Contractor's expense.

3.07 EROSION AND SEDIMENT CONTROLS

- A. Provide temporary erosion and sediment controls in accordance with Section 02316, Earthwork, the drawings and the erosion and sediment control plan approved by authorities having jurisdiction as applicable.

3.08 SHEETING, SHORING, AND BRACING

A. General:

1. Provide sheeting, shoring, bracing, and similar excavation supports as required for the Work.
2. Contractor is responsible for adequacy of all sheeting, shoring, bracing, and similar excavation supports.
3. Materials:
 - a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
 - b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
4. As excavation progresses, carry down shoring, bracing, and similar excavation supports to required elevation at bottom of excavation.
5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, and similar excavation supports.
6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facilities, their appearance, and adjacent construction.

B. Removal of Sheeting and Bracing:

1. Remove sheeting and bracing from excavations, unless otherwise directed by Engineer in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
 - a. Concrete has cured for not less than seven days.
 - b. Wall and floor framing, up to and including grade level floors, is in place.

3.09 TRENCH SHIELDS

- A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

- B. When using a shield for installing piping:
 - 1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
 - 2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.
- C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.
- D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

- A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.
- B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
 - 1. Engineer's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
 - 2. Inspection, testing, approval, and recording of locations of Underground Facilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
 - 5. Removal of trash and debris.
 - 6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
 - 7. Field testing of Underground Facilities including piping and conduits.
- C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.
- D. Placement – General:
 - 1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
 - 2. Place fill materials at moisture content and density as specified in this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before

compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.

3. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by Contractor shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.
4. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
5. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, Contractor shall perform all work required to provide the required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
7. Repair, at Contractor's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by Engineer.

E. Fill Against Concrete:

1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03005, Concrete.
2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:

1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:

1. Piping Installed in Fills Above Pre-construction Grade:
 - a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
2. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
3. Pipe Bedding: Pipe bedding material shall be as follows:
 - a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
 - b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
4. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
 - a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
 - b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.
 - c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.
 - d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of six inches each.

J. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Compaction Density Requirements:

1. Minimum density for fill materials shall be 100 percent of maximum density obtained in the laboratory in accordance with ASTM D698. Compaction of fill materials less than five feet below final grade, behind concrete walls, and pipe bedding materials when not located below structures or pavement shall be 95 percent of maximum density in accordance with ASTM D698.
2. Place fill in trenches below Underground Facilities, foundations or paved areas in horizontal, uncompacted lifts not greater than eight inches deep, and thoroughly compact each lift before placing the next lift. In other pipe trenches, horizontal uncompacted lifts shall be six inches deep.
3. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
 - a. On-site clayey soils: Optimum to plus three percent.
4. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.
5. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
6. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to Owner until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

- L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with the "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

A. General:

1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:

1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten-foot straight edge.

D. Compaction:

1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 PAVEMENT SUBBASE COURSE

A. General:

1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by Engineer.

B. Grade Control:

1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:

1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
2. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
3. Do not install pavement subbase in excess of 500 feet in length without compacting to prevent softening of the subgrade.
4. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material and replace with clean, compacted subbase material.

3.13 DISPOSAL OF EXCAVATED MATERIALS

A. General:

1. Contractor shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to Owner.

3.14 FIELD QUALITY CONTROL

A. Site Tests: Employ a testing laboratory to perform field quality control testing.

1. Testing Laboratory Scope:
 - a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
 - b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
 - c. Report results of each test to Engineer and Contractor.
2. Required Material Tests:
 - a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
3. Authority and Duties of Testing Laboratory:
 - a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to Engineer and Contractor. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of Engineer and Contractor to such failure.
 - b. Technician will not act as foreman or perform other duties for Contractor. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate Engineer for beneficial use or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.

4. Responsibilities and Duties of Contractor:
- a. Use of testing laboratory shall in no way relieve Contractor of the responsibility to provide materials and Work in full compliance with the Contract Documents.
 - b. To facilitate testing laboratory, Contractor shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
 - c. It shall be Contractor's responsibility to accomplish the specified compaction for fill and other earthwork. Contractor shall control construction operations by confirmation tests to verify and confirm that Contractor has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
 - d. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
 - 1) 10 linear feet of trench fill.
 - 2) 10 cubic yards of select fill.
 - 3) 10 cubic yards of general fill.
 - 4) 10 cubic yards of subbase material.
5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
- a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
 - 1) In Open Fields: Two locations every 25 linear feet.
 - 2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: One location every 25 linear feet.
 - 3) Crossing Paved Roads: Two locations along each crossing.
 - 4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 25 linear feet.
 - b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
 - c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
 - d. For General Fill: One per 100 square feet on every compacted lift.
 - e. Subbase Material: One per 100 square feet on every compacted lift.
6. Periodic compliance tests will be made by Engineer to verify that compaction is complying with the requirements specified, at no cost to Contractor. Contractor shall remove the

overburden above the level at which Engineer wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by Contractor.

END OF SECTION 02316

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SECTION 03005

CONCRETE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcing, and related materials.
2. The Work includes:
 - a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
 - b. Fabricating and placing reinforcing, including ties and supports.
 - c. Design, erection, and removal of formwork.
 - d. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
 - e. Providing openings in concrete as required to accommodate Work under this and other Sections.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:

1. Class "A" concrete shall be steel-reinforced and includes all concrete unless otherwise shown or indicated.
2. Class "B" concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
 - a. Concrete fill.
 - b. Duct banks.
 - c. Unreinforced encasements.
 - d. Sidewalks.

D. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ACI 224R, Control of Cracking in Concrete Structures.
2. ACI 301, Specifications for Structural Concrete for Buildings.
3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305R, Specification for Hot Weather Concreting.
5. ACI 306R, Cold Weather Concreting.
6. ACI 309R, Guide for Consolidation of Concrete.
7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ACI 347, Guide to Formwork for Concrete.
9. ACI SP-66, ACI Detailing Manual.
10. ASTM A1064/ASTM 1064M, Standard specification for Steel Carbon Steel Wire and Welded Wire, Reinforcement, Plain and Deformed, for Concrete.
11. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
12. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
13. ASTM C33/C33M, Specification for Concrete Aggregates.
14. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
15. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
16. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
17. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
19. ASTM C150/C150M, Specification for Portland Cement.
20. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
21. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
24. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.

25. ASTM C579, Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
26. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
27. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
28. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials
29. ASTM E1745, Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
30. CRD-C 572, U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops.
31. CRSI 1MSP, Manual of Standard Practice.

1.03 QUALITY ASSURANCE

A. Laboratory Trial Batch:

1. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
2. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
3. Perform the following testing on each trial batch:
 - a. Aggregate gradation for fine and coarse aggregates.
 - b. Slump.
 - c. Air content.
 - d. Compressive strength based on three cylinders each tested at seven days and at 28 days.
4. Submit for each trial batch the following information:
 - a. Project identification name and number (if applicable).
 - b. Date of test report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with the Contract Documents.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cementitious materials.
 - h. Brand, type, and amount of each admixture.

- i. Amounts of water used in trial mixes.
- j. Proportions of each material per cubic yard.
- k. Gross weight and yield per cubic yard of trial mixtures.
- l. Measured slump.
- m. Measured air content.
- n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. List of concrete materials and concrete mix designs proposed for use. Include results of tests performed to qualify the materials and to establish the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
- b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
- c. Concrete placement drawings showing the location and type of all joints.
- d. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4-inch to one foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.

2. Product Data:

- a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.

3. Samples:

- a. Samples: Submit samples of materials as specified and as otherwise requested by ENGINEER, including names, sources, and descriptions.

B. Informational Submittals: Submit the following:

1. Site Quality Control Submittals:

- a. Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of associated test. Test report shall include results of all testing required at time of sampling.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Transportation, Delivery, and Handling:

1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.

B. Storage:

1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.
3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.

PART 2 – PRODUCTS

2.01 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I/II. or ASTM C595, Type IL.

1. Type IL cement shall meet the following requirements:
 - a. Type IL cement shall have moderate sulfate resistance (MS).
 - b. Type IL cement shall have a maximum heat of hydration no more than 68 (cal/g) or 284.5 (KJ/kg) per ASTM 1702.
 - c. Type IL cement Tricalcium Aluminate content shall not exceed 8%.

B. Aggregates: ASTM C33/C33M.

1. Fine Aggregate: Clean, sharp, natural silica sand free of loam, clay, lumps, and other deleterious substances. Dune sand, bank run sand, and manufactured sand are unacceptable.

2. Coarse Aggregate:

- a. Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
- b. Coarse aggregate shall comply with the following:
 - 1) Crushed stone, processed from natural rock or stone.
 - 2) Washed gravel, either natural or crushed. Slag, pit gravel, and bank-run gravel are not allowed.
- c. Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER.

C. Water: Clean, potable.

D. Admixtures:

- 1. Air-Entraining Admixture: ASTM C260.
- 2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
- 3. Water Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
- 4. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.
- 5. Use only admixtures that have been tested and approved in the mix designs.
- 6. Do not use calcium chloride or admixtures containing chloride ions.

E. Cementitious Materials:

- 1. Fly Ash ASTM C618, Class F, content in cementitious material up to 20% by weight.
- 2. Slag ASTM C989, Grade 120, content in cementitious material up to 20% by weight.

2.02 CONCRETE MIX

A. General:

- 1. Normal weight: 145 pounds per cubic foot.
- 2. Use air-entraining admixture in all concrete. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.

B. Proportioning and Design of Class "A" Concrete Mix:

- 1. Minimum compressive strength at 28 days: 4,500 psi.
- 2. Maximum water-cement ratio by weight: 0.42.
- 3. Minimum cement content: 564 pounds per cubic yard.

C. Proportioning and Design of Class "B" Concrete Mix:

1. Minimum compressive strength at 28 days: 3,000 psi.
2. Maximum water-cement ratio by weight: 0.50.
3. Minimum cement content: 517 pounds per cubic yard.

D. Slump Limits:

1. Proportion and design mixes to result in concrete slump at point of placement of not less than one inch and not more than four inches.
2. When using high-range water reducers, slump prior to addition of admixture shall not exceed three inches. Slump after adding admixture shall not exceed eight inches at point of placement.

E. Adjustment of Concrete Mixes:

1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
2. Submit for ENGINEER's approval laboratory test data for adjusted concrete mix designs, including compressive strength test results.
3. Implement adjusted mix designs only after ENGINEER's approval.
4. Adjustments to concrete mix designs shall not result in additional costs to OWNER.

2.03 FORM MATERIALS

A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR shall be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.

B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces in accordance with ACI 301.

C. Unexposed Concrete Surfaces: Material to suit project conditions.

D. Provide 3/4-inch chamfer at all external corners. Chamfer is not required at re-entrant corners unless otherwise shown or indicated.

E. Form Ties:

1. Provide factory-fabricated, removable, or snap-off metal form ties, that prevent form deflection and prevent spalling of concrete surfaces upon removal. Materials used for tying forms are subject to approval of ENGINEER.
2. Unless otherwise shown or indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5 inches from outer surface of concrete. Unless otherwise shown or indicated, provide form ties that, upon removal, will leave a uniform, circular hole not larger than one-inch diameter in the concrete surface.

3. Ties for exterior walls, below-grade walls, and walls subject to hydrostatic pressure shall be provided with waterstops.
4. Wire ties are unacceptable.

2.04 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.
- B. Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete: ASTM A1064/ASTM A1064M.
- C. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
 1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
 2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
 3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
 4. Provide precast concrete supports over waterproof membranes.
- D. Adhesive Dowels:
 1. Dowels:
 - a. Dowel reinforcing bars shall comply with ASTM A615, Grade 60.
 2. Adhesive:
 - a. For requirements for adhesive, refer to Section 05051, Anchor Systems.

2.05 RELATED MATERIALS

- A. Waterstops:
 1. PVC Waterstops:
 - a. Manufacturers: Provide products of one of the following:
 - 1) W.R. Meadows, Inc.
 - 2) Greenstreak Plastic Products Company.
 - 3) Or approved equal.
 - b. Waterstops shall comply with CRD-C 572. Do not use reclaimed or scrap material.

- c. Minimum Thickness: 3/8-inch.
 - d. Provide waterstops with minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum 1/8-inch in height.
 - e. Construction Joints: Waterstops shall be six-inch wide flat-strip type.
 - f. Expansion Joints: Waterstops shall be nine-inch wide centerbulb type.
2. Hydrophilic Waterstops:
- a. Products and Manufacturers: Provide one of the following:
 - 1) Duroseal Gasket, by BBZ USA, Inc.
 - 2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
 - 3) Hydrotite, by Greenstreak Plastic Products Company.
 - 4) Or approved equal.
 - b. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
 - c. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
 - d. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
 - e. Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
 - f. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
 - g. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by ENGINEER.
 - h. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.
 - 1) Products and Manufacturers: Provide one of the following:
 - a) Duroseal Paste, by BBZ USA, Inc.
 - b) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
 - c) Hydrotite, by Greenstreak Plastic Products Company.
 - d) Or approved equal.

B. Vapor Retarder:

1. Products and Manufacturers: Provide one of the following:
 - a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
 - b. Griffolyn 10-mil, by Reef Industries.
 - c. Moistop Ultra, by Fortifiber Industries.
 - d. Or approved equal.
2. Vapor retarder membrane shall comply with the following.
 - a. Water Vapor Transmission Rate, ASTM E96/E96M: 0.04 perms or lower.
 - b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
 - c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
 - d. Provide accessories by same manufacturer as vapor retarder.

C. Membrane-Forming Curing Compound: ASTM C309, Type I.

D. Epoxy Bonding Agent:

1. Two-component epoxy resin bonding agent.
2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
 - b. Eucopoxy LPL, by the Euclid Chemical Company.
 - c. Or approved equal.

E. Epoxy-Cement Bonding Agent:

1. Three-component blended epoxy resin-cement bonding agent.
2. Products and Manufacturers: Provide one of the following:
 - a. Sika Armatec 110 EpoCem, by Sika Corporation.
 - b. Duralprep A.C., by Euclid Chemical Company.
 - c. Or approved equal.

F. Preformed Expansion Joint Filler:

1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

G. Joint Sealant and Accessories:

1. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07920, Joint Sealants.

2.06 GROUT

A. Non-shrink Grout:

1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
2. Minimum 28-day Compressive Strength: 7,000 psi.
3. Products and Manufacturers: Provide one of the following:
 - a. NS Grout by Euclid Chemical Company.
 - b. Set Grout by Master Builders, Inc.
 - c. NBEC Grout by Five Star Products, Inc.
 - d. Or approved equal.

B. Epoxy Grout:

1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
3. Products and Manufacturers: Provide one of the following:
 - a. Euco High Strength Grout, by Euclid Chemical Company.
 - b. Sikadur 42, Grout Pak, by Sika Corporation.
 - c. Five Star Epoxy Grout, by Five Star Products, Inc.
 - d. Or approved equal.

C. Grout Fill:

1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
2. Proportion and mix grout fill as follows:
 - a. Minimum Cement Content: 564 pounds per cubic yard.
 - b. Maximum Water-Cement Ratio: 0.45.
 - c. Maximum Coarse Aggregate size: 1/2-inch, unless otherwise indicated.
 - d. Minimum 28-day Compressive Strength: 4,000 psi.

PART 3 – EXECUTION

3.01 INSPECTION

- A. CONTRACTOR shall examine the substrate and the conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 FORMWORK

- A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.
- C. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
- D. Removing Formwork:
 - 1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
 - 2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
 - 3. Removal time for formwork is subject to ENGINEER's acceptance.
 - 4. Repair form tie-holes following in accordance with ACI 301.

3.03 REINFORCING, JOINTS, AND EMBEDDED ITEMS

- A. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.
- B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
- C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
 - 1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
 - 2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

- D. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- E. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown or indicated for minimum lap of spliced bars, as shown on Drawings.
- F. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.
- G. Do not place concrete until reinforcing is inspected and ENGINEER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify ENGINEER in writing at least two working days prior to proposed concrete placement.
- H. Construction Joints:
 - 1. Comply with requirements of ACI 301 and the Contract Documents.
 - 2. Locate and install construction joints as shown or indicated on the Drawings. Where not shown or indicated, locate joints to not impair strength of the structure; position joints at points of minimum shear. Location of joints shall be approved by ENGINEER. In addition to joints shown or indicated on the Drawings, locate construction joints as follows:
 - a. In foundation mats, locate joints at spacing of approximately 40 feet. Joints shall be located within middle third of element span, unless otherwise shown or indicated on the Drawings. Element span shall be considered distance between piles or, as determined by ENGINEER, distance between bearing elements, such as columns, exterior walls and interior walls. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
 - b. In walls, locate joints at a maximum spacing of 40 feet. Locate joints away from wall intersections a minimum of one-quarter of the clear span distance between wall intersections measured horizontally.
 - c. In structural slabs and beams, joints shall be located within middle third of element span and shall be located in compliance with ACI 301, unless otherwise shown or indicated on the Drawings.
 - d. In slabs on grade, locate joints at spacing of approximately 40 feet. Place concrete in strip pattern, unless otherwise shown or indicated on the Drawings.
 - 3. Horizontal Joints:
 - a. Roughen concrete at interface of construction joints by abrasive blasting, hydroblasting, or using surface retardants and water jets to expose aggregate and remove accumulated concrete on projecting rebar immediately subsequent to form stripping, unless otherwise approved by ENGINEER. Immediately before placing fresh concrete, thoroughly clean existing contact surface using stiff brush or other tools and stream of pressurized water. Surface shall be clean and wet, and free from pools of water at time of placing fresh concrete.
 - b. Remove laitance, waste mortar, and other substances that may prevent complete adhesion. Where joint roughening was performed more than seven days prior to concrete placing or where dirt or other bond reducing contaminants are on surface, perform additional light abrasive blasting or hydroblasting to remove laitance and all bond-reducing materials just prior to concrete placement.

4. Vertical Joints:

- a. Apply roughener to the form in thin, even film by brush, spray, or roller in accordance with manufacturer's instructions. After roughener is dry, concrete may be placed.
 - b. When concrete has been placed, remove joint surface forms as early as necessary to allow for removal of surface retarded concrete. Wash loosened material off with high-pressure water spray to obtain roughened surface subject to approval by ENGINEER. Alternately, surface shall be roughened by abrasive blasting or hydroblasting to expose aggregate. Outer one-inch of each side of joint face shall be masked and protected from blasting to avoid damaging member surface.
5. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4-inch.

I. Isolation Joints:

1. Provide isolation joint where sidewalk or other slab on grade abuts a concrete structure and slab on grade is not shown doveled into that structure. Form isolation joint by 1/2-inch joint filler with upper 1/2-inch of joint filled with sealant.

J. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections and, when applicable, other contracts for locating and setting. Refer to Paragraph 1.01.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

K. Adhesive Dowels:

1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer's installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.
2. Drill holes to adhesive system manufacturer's recommended diameter and depth to develop required tensile strength. Where indicated on the drawings, hole depths greater than required for tensile development shall be provided. Hammer-drill holes. Cored holes are not allowed.
3. Embedment depths shall be based on concrete compressive strength of 4,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
4. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by ENGINEER.
5. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.

6. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge end as adhesive is placed but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.
7. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.

3.04 CONCRETE PLACING

- A. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.
- B. Ready-Mixed Concrete: Comply with ASTM C94/C94M.
- C. Concrete Placing:
 1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
 2. Do not begin placing concrete until work of other trades affecting concrete is completed.
 3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
 4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
 5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than four feet during placing.
 6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.
- D. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.
- E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
 1. In hot weather comply with ACI 305R.
 2. In cold weather comply with ACI 306R.

3.05 QUALITY OF CONCRETE WORK

- A. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
- B. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
- C. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.

- D. Repair, removal and replacement of defective concrete directed by ENGINEER shall be at no additional cost to OWNER.

3.06 CURING

- A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.07 FINISHING

A. Slab Finish:

1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.
2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
4. Use trowel finish for the following:
 - a. Interior exposed slabs, unless otherwise shown or indicated.
 - b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.

- B. Apply liquid sealer/densifier to exposed interior concrete floor areas when cured and dry, in accordance with manufacturer's instructions.

C. Formed Finish:

1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8-inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.
2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2-inch in height.

3.08 GROUT PLACING

- A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER and not proceed until obtaining ENGINEER's clarification.
- B. Dry-packing is not allowed, unless otherwise indicated.
- C. Manufacturers of proprietary grout materials shall make available upon 72 hours' notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.
- D. Placing grout shall comply with temperature and weather limitations described in Article 3.04 of this Section.

3.09 FIELD QUALITY CONTROL

- A. Site Testing Services:
 - 1. CONTRACTOR shall employ independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are obtained.
 - 2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
 - 3. CONTRACTOR shall provide curing and necessary cylinder storage.
- B. Quality Control Testing During Construction:
 - 1. Perform sampling and testing for field quality control during concrete placing, as follows:
 - a. Sampling Fresh Concrete: ASTM C172.
 - b. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
 - c. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
 - d. Air Content: ASTM C231; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
 - e. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
 - f. Compression Test Specimens:
 - 1) In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
 - 2) Cast, store, and cure specimens in accordance with ASTM C31/C31M.

- g. Compressive Strength Tests:
 - 1) In accordance with ASTM C39/C39M; one specimen tested at seven days, and three specimens tested at 28 days.
 - 2) Concrete that does not comply with strength requirements will be considered as defective Work.
 - h. Submit test results from certified by testing laboratory to ENGINEER within 24 hours of completion of test.
 - i. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M and the following:
 - 1) Obtain at least three representative cores from each concrete member or suspect area of concrete at locations directed by ENGINEER.
 - 2) Strength of concrete for each series of cores will be acceptable if average compressive strength is at least 85 percent of specified compressive strength and no single core is less than 75 percent of required 28-day required concrete compressive strength.
 - 3) Testing laboratory shall submit test results to ENGINEER on same day that tests are completed. Include in test reports Project name and number (if any), date of sampling and testing, CONTRACTOR name, name of concrete testing laboratory, exact location of test core in the Work, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength, and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of concrete as placed, and moisture condition of the core at time of testing.
 - j. Fill core holes solid with non-shrink grout in accordance with this Section and finish to match adjacent concrete surfaces.
 - k. If results of core tests are unacceptable or if it is impractical to obtain cores, perform static load test and evaluations complying with ACI 318 and ACI 350, as directed by ENGINEER.
2. OWNER Will employ testing laboratory to perform special inspections testing of adhesive dowels at the Site.
- a. Testing shall comply with ASTM E488 and Special Inspections Requirements.
 - b. After adhesive system manufacturer's recommended curing period and prior to placing connecting reinforcing, proof-test for pullout ten percent of adhesive dowels installed. If one or more dowels fail the test, CONTRACTOR shall pay cost to test all dowels of same diameter and type installed on the same day as the failed dowel.
 - c. Test dowels to 60 percent of specified yield strength. ENGINEER will direct which dowels are to be tested.
 - d. Apply test loads with hydraulic ram.

- e. Displacement of dowels shall not exceed $D/10$, where D is nominal diameter of dowel.
- f. Dowels that fail shall be reinstalled and retested at CONTRACTOR's expense.

END OF SECTION 03005

NO TEXT ON THIS PAGE

SECTION 03930

REPAIR AND REHABILITATION OF CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to repair or rehabilitate, as required, all existing concrete shown or indicated in the Contract Documents as being repaired or rehabilitated.
2. CONTRACTOR shall repair all damage to new concrete construction as specified in this Section except for repair Work specified in Section 03005, Concrete.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the Work that must be installed with or before repair and rehabilitation of concrete.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 03005, Concrete.
3. Section 05051, Anchor Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
2. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
3. ASTM C510, Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
4. ASTM C661, Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
5. ASTM C793, Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.
6. ASTM C794, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
7. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
8. ASTM C920, Standard Specification for Elastomeric Joint Sealants.

9. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
10. ASTM D1752, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
11. ASTM D3574, Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams.
12. ASTM G109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.
13. FS TT S 00227E, Interim Federal Specification for Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures).

1.03 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Product Data: Information on all products proposed for use, including manufacturer's brochures, technical data, specifications, and other applicable data.
- B. Informational Submittals: Submit the following:
 1. Manufacturer's Instructions: Manufacturer's recommended procedures for installing materials proposed for use.
 2. Special Procedure Submittals: When requested by ENGINEER, submit information on methods for supporting during demolition and repair Work existing structures, pipes, and other existing facilities affected by the Work.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery and Handling of Materials:
 1. Conform to Section 01600, Materials and Equipment, and this Section.
 2. Clearly mark on containers manufacturer's name and label, name or title of material, manufacturer's stock number, and date of manufacture.
 3. Handle materials carefully to prevent inclusion of foreign matter.
 4. Do not open containers or mix components until necessary preparatory Work has been completed and application Work is to start immediately.
- B. Storage of Materials:
 1. Conform to Section 01600, Materials and Equipment, and this Section.
 2. Store only approved materials at the Site.

PART 2 – PRODUCTS

2.01 REPAIR MORTAR

A. Product Description: Repair mortar shall be prepackaged, cement-based product specifically formulated for repairing concrete surface defects.

B. Products and Manufacturers: Provide one of the following:

1. SikaTop 122 Plus, SikaTop 123 Plus, or SikaTop 126 Plus, by Sika Corporation.
2. DuralTop Gel, DuralTop Flowable Mortar by Euclid Chemical Company.
3. Tnemec Series 217 MortarCrete
3. Or approved equal.

C. Materials:

1. Provide a two-component, polymer-modified, Portland cement, fast-setting, trowel-grade mortar. Repair mortar shall be enhanced with penetrating corrosion inhibitor, and shall have the following properties:

Physical Property	Value	ASTM Standard
Minimum Compressive Strength at One Day	2,000 psi	C109
Minimum Compressive Strength at 28 Days	6,000 psi	C109
Minimum Bond Strength at 28 Days	1,800 psi	C882*

* Modified for use with repair mortars.

2. Where the least dimension of the placement in width or thickness exceeds four inches, extend repair mortar by adding aggregate as recommended by repair mortar manufacturer.

2.02 EXPANSION JOINT REPAIR SYSTEM

A. System Description: Joint repair system shall consist of two components: Preformed Joint Filler and Two component Polyurethane Sealant.

B. Products, Manufacturers, and Materials:

1. Preformed Joint Filler
 - a. Provide preformed expansion joint filler complying with ASTM D 1752, Type I (sponge rubber) or Type II (cork).
2. Two component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.
 - b. Polyurethane based, two component elastomeric sealant complying with:

- 1) FS TT S 00227E: Type II (non sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
- 2) Adhesion in Peel, FS TT S 00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
- 3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
- 4) Stain and color change, FS TT S 00227E and ASTM C510: No discoloration or stain.
- 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
- 6) Rheological Vertical Displacement at 120 degrees F, FS TT S 00227E: No sag.
- 7) VOC Content: 220 grams per liter, maximum

2.03 ANTI-CORROSION COATING REINFORCEMENT PROTECTION

- A. Product Description: Anti-corrosion coating shall be a 3 component, solvent free, moisture tolerant, epoxy modified cementitious product formulated for reinforcement protection. Provide two coats at coverage of 40 square feet per gallon per coat.
- B. Products and Manufacturers: Provide one of the following:
 1. Sika Armatec 110 EpoCem, by Sika Corporation.
 2. Or approved equal.

2.04 PROTECTIVE SLURRY MORTAR

- A. Product Description: Material shall be two-component, polymer-modified, cementitious waterproofing and protective slurry mortar. Provide two coats at coverage of 50 square feet per gallon per coat.
- B. Products and Manufacturers: Provide one of the following:
 1. Sikatop Seal 107, by Sika Corporation.
 2. Or approved equal.

2.05 CRACK INJECTION MATERIALS

- A. Structural Crack Repair System:
 1. Epoxy for injection shall be low-viscosity, high-modulus moisture insensitive type.
 2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 35, Hi Mod L.V. and Sikadur 31, Hi-Mod Gel, by Sika Corporation.
 - b. Eucopoly Injection Resin, by Euclid Chemical Company.
 - c. Or approved equal.
- B. Non-structural Crack Repair System:

1. Hydrophobic Polyurethane Chemical Grout:
 - a. Provide hydrophobic polyurethane that forms a flexible gasket.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) SikaFix HH LV, by Sika Chemical Company.
 - 2) Hydro Active Flex SLV, by De Neef Construction Chemicals, Inc.
 - 3) Or approved equal.
 - c. Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
 - d. Minimum elongation of 250 percent in accordance with ASTM D3574.
 - e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
2. Hydrophilic Acrylate-Ester Resin:
 - a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume by at least 50 percent when in contact with water.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Duroseal Multigel 850, manufactured by BBZ USA, Inc.
 - 2) Superflex AR, by De Neef Construction Chemicals, Inc.
 - 3) Or approved equal.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which the repair Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation:
 1. Initial Surface Preparation: Remove by chipping, abrasive blasting, or hydro blasting all laitance, foreign material, and unsound concrete from entire area to be repaired. Further roughen surface as specified in this Section. Where non-shrink grout or repair mortar is used, perform additional surface preparation, if any, recommended by product manufacturer.
 2. Wetting Procedure: Where repair concrete, shotcrete, or cement grout is used, and bonding agent is not required, or where repair mortar or non-shrink grout manufacturer recommends wet or saturated surface, perform the following:
 - a. Continuously apply water for at least four hours to surface being repaired. Where large surface areas are to be repaired, use fog-spray nozzles, mounted on stands, in sufficient number so that entire surface to be repaired is contacted by fog spray cloud.

- b. Prevent concrete from drying until after repair is completed. Re-wet surfaces not yet repaired using water sprays at least a daily; should more than four days elapse without re-wetting surfaces not yet repaired, repeat the original saturating procedure.
 - c. Remove standing water in areas to be repaired before placing repair material. Provide means to remove excess water from structure.
- 3. Preparation for Epoxy Bonding Agent: Where repair material manufacturer recommends use of epoxy-bonding agent, conform to recommendations of both repair material manufacturer and bonding agent manufacturer.

3.03 INSTALLATION, GENERAL

- A. Construction Tolerances: Shall be as specified in Section 03005, Concrete, except as specified in this Section and elsewhere in the Contract Documents.
- B. Care shall be taken to fully consolidate repair material, completely filling all portions of space to be filled.
- C. Bring surface being repaired into alignment with adjacent surfaces, providing uniform, even surface. Surface repaired shall match adjacent existing surfaces in texture and shall receive coatings or surface treatments, if any, provided for the existing surface adjacent to repaired surface.
- D. Curing:
 - 1. Curing of repair mortar and non-shrink grout shall be in accordance with manufacturer's recommendations, except that minimum cure period shall be three days.
 - 2. Curing of other materials shall be in accordance with requirements of Section 03005, Concrete.

3.04 REPAIR OF SURFACE DEFECTS

- A. Surface defects are depressions in a concrete surface that do not extend all the way through the concrete. Surface defects can result from removal of an embedded item, removal of an intersecting concrete member, physical damage, or unrepaired rock pockets created during original placement. For spalls that result from corroded reinforcing steel or other embedment refer to Article 3.07 of this Section.
- B. Preparation: Perform the following in addition to requirements of Article 3.02 of this Section:
 - 1. Remove by chipping all loose, damaged concrete to sound material.
 - 2. Where existing reinforcing is exposed, remove concrete to minimum of one-inch around exposed bars. If existing bars are cut through, cracked, or cross sectional area is reduced by more than 25 percent from original, immediately notify ENGINEER.
 - 3. Score-cut perimeter of area to be repaired to minimum depth of 1/2-inch and maximum depth that will not cut existing reinforcing steel. Chip out existing concrete to the score line so that minimum thickness of repair mortar will be 1/2-inch.
- C. Repair Material:
 - 1. Completely fill the surface defect with specified repair material, in accordance with material manufacturer's instructions and the Contract Documents.

2. Perform, with repair mortar, repairs of surface defects in concrete normally in contact with water or soil, and interior surfaces of structures that contain water.
3. Repair of other surface defects may be by applying repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.05 PATCHING OF HOLES IN CONCRETE

- A. Fill openings less than 4-in. in their least dimension with repair mortar.
- B. Openings greater than or equal to four inches and less than 8-in. in their least dimension shall be coated with an epoxy bonding agent prior to filling with Non-shrink grout, in accordance with Section 03005, Concrete.
- C. Openings greater than or equal to 8-in and less than 12-in. in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class A concrete in accordance with Section 03005, Concrete.
- D. Openings equal to or greater than 12 inches in their least dimension shall be repaired as shown in the contract drawings.
- E. Where repaired holes are in contact with water or soil, provide hydrophilic rubber waterstop within the opening in accordance with Section 03005, Concrete, prior to filling with repair material.

3.06 REPAIR OF LINED HOLES

- A. This Article applies to openings with embedded material over all or a portion of inside surface of hole. Where indicated on the Drawings, remove embedded materials and repair the hole in accordance with Article 3.05 of this Section, as modified in this Article 3.06.
- B. Where embedded material is allowed to remain, remove embedded material to at least two inches into the hole, as measured from the plane surface of concrete wall or slab, as applicable. Embedded material left in place shall be roughened or abraded for proper bonding to repair material. Completely remove substances that interfere with proper bonding.
- C. Completely remove embedded items not securely and permanently anchored into concrete.
- D. Completely remove embedded items larger than 12 inches in their smallest dimension. In lieu of removing the embedded item, where reinforcing is required as shown or indicated in the Contract Documents, weld reinforcing to embedded item to remain, provided embedded item to remain is composed of metal to which reinforcing steel can be welded.

3.07 REPAIR OF DETERIORATED CONCRETE

- A. This Article pertains to deteriorated concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, or damage due to chemical attack. Use repair mortar, as specified in this Article, for repairing deteriorated concrete. Where repaired surface will be subsequently covered with plastic liner material, coordinate finishing with requirements for installing plastic liner material.
- B. Surface Preparation: In addition to requirements of Article 3.02 of this Section, perform the following surface preparation:
 1. Remove loose, broken, softened, and acid-contaminated concrete by abrasive blasting and chipping to sound, uncontaminated concrete.

2. Upon completion of removal of deteriorated concrete, notify ENGINEER in writing. Allow two weeks for ENGINEER to evaluate the surface, perform testing for acid contamination if required, determine if additional concrete shall be removed, and to develop special repair details (if any) required. Should ENGINEER determine that additional concrete be removed to reach sound, uncontaminated concrete, allow another two-week period for further evaluation and testing following the additional removal.
3. Surface preparation shall conform to recommendations of repair mortar manufacturer.
4. Repair and rehabilitate isolated areas of exposed reinforcing bars in accordance with Article 3.04 of this Section. If extensive areas of reinforcing steel are uncovered after removal of deteriorated concrete, ENGINEER will determine the repair methods required.

C. Repair Mortar Placing:

1. Conform to manufacturer's recommended procedures for mixing and placing repair mortar.
2. After initial mixing of repair mortar, addition of water is not allowed.
3. Minimum Thickness:
 - a. Install repair mortar to not less than minimum thickness recommended by manufacturer, and not less than 1/2-inch.
 - b. Where removal of deteriorated concrete results in repair thickness of less than minimum required thickness to return to original concrete surface in isolated areas totaling less than ten percent of total repair surface area, remove additional concrete to obtain at least the required minimum thickness.
 - c. Where surface area with repair thickness less than minimum required thickness exceeds ten percent of total repair area, notify ENGINEER.
 - d. Provide repair mortar so that minimum cover over existing reinforcing steel is two inches. Do not place repair mortar creating locally raised areas.
 - e. Where transitioning to or from wall surfaces not requiring repair, do not feather-out repair mortar at transition. Instead, form the transition by saw cutting a score line to not less than minimum required repair mortar depth and chip out concrete to the saw cut line. Do not cut or otherwise damage reinforcing steel.
4. Place repair mortar to an even, uniform plane to restore concrete member to its original surface. Out-of-plane tolerance shall be such that the gap between 12-inch long straight edge and repair mortar surface does not exceed 1/8-inch, and gap between a four-foot long straight edge and repair mortar surface shall not exceed 1/4-inch. Tolerances specified in this paragraph apply to straight edges placed in any orientation at any location.

D. Finishing:

1. Provide smooth, steel trowel finish to repair mortar.
2. When completed, there shall be no sharp edges. Provide exterior corners, such as at penetrations, one-inch radius. Interior corners shall be square, except corners to receive plastic lining which shall be made with two-inch fillet in repair mortar.

3.08 REPAIR OF EXPANSION JOINTS

- A. Surface Preparation: Remove the following from surfaces to be repaired: laitance, foreign material, and unsound concrete. Remove by chipping, abrasive blasting, or hydro blasting. Additional surface preparation, if required, shall be as recommended by expansion joint repair system manufacturer.
- B. Installation: Installation shall be as recommended by Joint Filler and Sealant manufacturer.

3.09 REPAIR OF EXPOSED REINFORCING

- A. Remove, by abrasive blasting or hydro blasting, all corrosion, foreign materials, and unsound concrete from area to be repaired.
- B. Surface shall be visually dry before applying corrosion inhibitor. Liberally apply anti-corrosion coating, 20 mils thickness per coat. Provide two coats. Time between coats shall be the longer of: one hour, or as recommended by manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.
- C. After applying final coat of allow it to dry before corrosion inhibitor or repair mortar is applied.
- D. For mortar coating, conform to Paragraphs 3.7.C, 3.7.D, 3.7.E of this Section.

3.10 PROTECTIVE SLURRY MORTAR COATING

- A. Remove, by abrasive blasting or hydro blasting, all corrosion, foreign materials, and unsound concrete from area to be repaired.
- B. Surface shall be visually dry before applying anti-corrosion coating. Liberally apply anti-corrosion coating, 20 mils thickness per coat. Provide two coats. Time between coats shall be the longer of: two hours, or as recommended by manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.
- C. Apply protective slurry mortar per manufacturer recommendations.

3.11 CRACK INJECTION

- A. Examine areas under which injection Work will be installed and locate cracks that require injection. Identify and inject cracks greater than 0.010-inch wide in structures that retain or contain water, wastewater, or similar liquid.
- B. Install injection material in accordance with crack injection manufacturer's requirements.
- C. After injecting and curing, verify that injected material penetrated the crack adequately and that there is no visible leakage through the crack. After injecting, if crack continues to leak, re-inject crack at no additional cost to OWNER until structure is watertight.
- D. If proper penetration of crack cannot be achieved, submit to ENGINEER a proposed alternate approach for modifying the specified injection procedure to properly seal the crack. In new concrete and in concrete cracked as a result of CONTRACTOR's operations, perform modifications to crack injection procedure and fully repair the crack without additional cost to OWNER or extension of the Contract Times.

3.12 SITE QUALITY CONTROL

- A. OWNER will employ and pay for services of testing laboratory for Site quality control testing. ENGINEER will direct the number of tests and specimens required, including providing necessary materials for making and facility for storing test specimens. CONTRACTOR shall make standard compression test specimens as specified in this Section under the observation of ENGINEER. CONTRACTOR shall provide:
1. Necessary assistance required by ENGINEER.
 2. All labor, material, and equipment required, including rods, molds, thermometer, curing in heated storage box, and all other incidentals required, subject to approval by ENGINEER.
 3. All necessary storage, curing, and transportation required for testing.
 4. CONTRACTOR will be charged for cost of additional testing and investigation, if any, for Work performed that is not in accordance with the Contract Documents or is otherwise defective.
- B. Site Tests of Cement-based Grouts and Repair Mortar:
1. Obtain compression test specimens during construction from first placement of each type of mortar or grout, and at intervals thereafter as selected by ENGINEER, to verify compliance with the Contract Documents. Specimens will be made by ENGINEER or ENGINEER's representative.
 2. Compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed in accordance with ASTM C109. Set of three specimens will be made for each test. Tests will be made at seven days, 28 days, and additional time periods as deemed appropriate by ENGINEER.
 3. Bond strength field tests during construction will be performed from first placement of each type of mortar, or grout, and at intervals thereafter selected by ENGINEER, to verify compliance with the Contract Documents.
 4. Bond strength field tests for repair mortar and non-shrink grout will be performed in accordance with ASTM C882 modified for in place construction.
 5. Material, already placed, failing to conform to the Contract Documents, is defective.
- C. Repair Concrete: Repair concrete shall be tested as required in Section 03005, Concrete.

END OF SECTION 03930

SECTION 04005

MASONRY

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified and required for masonry Work, including:
 - a. Providing openings in unit masonry construction to accommodate the Work under this and other Specification Sections, and building into unit masonry construction all items such as sleeves, anchorage devices, inserts and other items to be embedded in unit masonry construction for which placement is not specifically provided under other Specification Sections.
2. Extent of each type of unit masonry is shown.
3. Types of products and features required include:
 - a. Masonry mortar and grout.
 - b. Sound Block.
 - c. Brick.
 - d. Masonry accessories.

B. Coordination:

1. Review installation procedures under other Specification Sections and coordinate the items that must be installed with unit masonry construction Work.
2. Unit masonry construction done without built-in flashings and other built-in Work shall be removed and rebuilt at no additional cost to OWNER, even if discovered after apparent completion of unit masonry construction.
3. Coordinate Work under other Specification Sections to avoid delay of masonry construction.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 05501, Miscellaneous Metal Fabrications.
3. Section 07650, Flexible Masonry Flashing.
4. Section 07920, Joint Sealants.
5. Section 09900, Painting.

1.02 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:

1. ACI 530, Building Code Requirements for Masonry Structures.
2. ACI 530.1, Specification for Masonry Structures.
3. ASTM A36, Standard Specification for Carbon Structural Steel.
4. ASTM A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
5. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A615, Standard Specification for Deformed and Plain Carbon - Bars for Concrete Reinforcement.
7. ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
8. ASTM A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Low-Alloy with Improved Formability.
9. ASTM C5, Standard Specification for Quicklime for Structural Purposes.
10. ASTM C33, Standard Specification for Concrete Aggregates.
11. ASTM C67, Standard Test Method for Sampling and Testing Brick and Structural Clay Tile.
12. ASTM C90, Standard Specification for Hollow Load-Bearing Concrete Masonry Units.
13. ASTM C91, Standard Specification for Masonry Cement.
14. ASTM C62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
15. ASTM C129, Standard Specification for Non-loadbearing Concrete Masonry Units.
16. ASTM C136, Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates.
17. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
18. ASTM C144, Standard Specification for Aggregate for Masonry Mortar.
19. ASTM C150, Standard Specification for Portland Cement.
20. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.
21. ASTM C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
22. ASTM C270, Standard Specification for Mortar for Unit Masonry.

23. ASTM C331, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
24. ASTM C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
25. ASTM C404, Standard Specification for Aggregates for Masonry Grouts.
26. ASTM C426, Standard Test Method for Linear Drying Shrinkage of Concrete Block.
27. ASTM C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
28. ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
29. ASTM C1019, Standard Test Method for Sampling and Testing Grout.
30. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.
31. ASTM C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
32. ASTM D2240, Standard Test Method for Rubber Property- Durometer Hardness.
33. ASTM D2287, Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
34. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
35. ASTM E119, Standard Test Method for Fire Tests of Building Construction and Materials.
36. BIA, Technical Notes on Brick and Tile Construction.
37. BIA, Technical Bulletin 1A, Construction and Protection Recommendations for Cold Weather Masonry Construction.
38. BIA, Technical Notes on Cleaning Clay Products Masonry.
39. NCMA, Guide Specifications and Technical Bulletins.
40. UL 901, Specification for Quicklime for Structural Purposes.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Installer: Hire a single installer regularly engaged in preformed unit masonry installation and with successful and documented experience in erecting unit masonry of scope and type of Work required; and employs only tradesmen with specific skill and successful experience in this type of Work. Submit name and qualifications to ENGINEER with the following information for at least three successful, completed projects:
 - a. Names and telephone numbers of owners, architects or engineers responsible for project.

- b. Approximate contract cost of unit masonry for which installer was responsible.
 - c. Amount (square feet) of unit masonry installed.
 - 2. Laboratory Qualifications:
 - a. Testing Laboratory: In accordance with ASTM C1093.
- B. Component Supply and Compatibility:
 - 1. Obtain each type of concrete masonry unit from one Supplier, cured by one process and of uniform texture and color, or in an established uniform blend thereof.
 - 2. Do not change source or brands of mortar products during the Project.
 - 3. Where question of compliance to requirements of this Section arise, mortar properties Specification will take precedence over mortar proportion Specification.
 - 4. Do not change proportions established for mortar accepted under property Specifications, and do not use products with different physical characteristics in mortar used in the Work, unless compliance with requirements of property Specifications is re-established by submitting acceptable data to ENGINEER.
 - 5. Do not combine two air-entraining materials in mortar.
- C. Vibration, Seismic, and Wind Requirements: Contractor responsible for this Section shall provide seismic, vibration, and wind controls for Work specified in this Section, complying with Section 15050, Vibration, Seismic, and Wind Controls.
- D. Job Mock-up:
 - 1. Prior to installing unit masonry and after ENGINEER's approval of Samples, erect job mock-ups using products, pattern bond, and joint tooling shown or specified. Build mock-up at the Site, at a location approved by the ENGINEER, of full required wall thickness. Mock-up shall be approximately 8.0 feet by 4.00 feet unless another size or location is shown as job mock-up. Provide special features as directed, including finished opening 16 inches by 16 inches, finished end, masonry control joint, and precast lintel units. Indicate proposed range of color, texture and workmanship to be expected in completed Work. Obtain ENGINEER's approval of visual qualities of mock-up before starting unit masonry construction. Retain and protect mock-up during construction as a standard for judging unit masonry Work. Do not alter, move, or destroy mock-up until receiving written permission by ENGINEER.
 - 2. Build as many mock-up panels as required to obtain ENGINEER's approval.
 - 3. Perform unit masonry construction tests per ACI 530.1. Provide to ENGINEER acceptable test results before starting masonry construction.
 - 4. Masonry construction that does not meet standards approved on mock-up panel shall be removed and rebuilt to conform to the Contract Documents. Provide mock-up panel for the following:
 - a. Typical complete exterior wall including cavity wall flashing, anchors, and masonry wall ties and all other components of complete exterior wall system.

E. Masonry Pre-installation Conference:

1. Prior to starting unit masonry construction Work, schedule and hold masonry pre-installation conference at the Site, to review foreseeable methods and procedures related to unit masonry Work including:
 - a. Project requirements per the Contract Documents.
 - b. Structural concept.
 - c. Sequence of masonry construction.
 - d. Special masonry details.
 - e. Required submittals.
 - f. Standard of workmanship.
 - g. Prism tests or mortar, grout sample and unit masonry tests results.
 - h. Quality control requirements.
 - i. Job organization and availability of products, tradesmen, equipment, and facilities needed to conform to Progress Schedule.
 - j. Masonry control and expansion joint location and materials.
 - k. Modular planning requirements.
 - l. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
 - m. Required special inspection, testing, and certifying procedures.
 - n. Compliance with building codes and other Laws and Regulations.
 - o. Construction Waste Management Plan requirements.
2. Attendance is mandatory for the following:
 - a. CONTRACTOR's Site superintendent.
 - b. Masonry Subcontractor's Site superintendent.
 - c. Masonry Subcontractor's foreman.
 - d. Authorized representative of unit masonry Suppliers.
 - e. ENGINEER.
 - f. Special Inspection Coordinator.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. CONTRACTOR shall record discussions of conference and decisions and agreements (or disagreements) and provide copy of record to each conference attendee.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit the following:

- a. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show details for each condition encountered in the Work. Provide plan and elevation views drawn at a scale of 1/4-inch equal to 1.0 foot, and details drawn at a scale of 1.5-inch equal to 1.0 foot. Show all items included in unit masonry construction.
- b. Shop Drawings showing location, extent and accurate configuration and profile of all items shown, specified, and required by this and other Specification Sections included in unit masonry construction.
- c. Shop Drawing for fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabricating and placing reinforcing for unit masonry Work.
- d. Job Mock-up: Shop Drawings showing location, extent, and accurate configuration of all items to be built into the mock-up. Provide elevations drawn at scale of 1.5 inch equal to 1.0 foot.

2. Product Data: Submit the following:

- a. Copies of manufacturer's specifications and test data for each type of concrete masonry unit specified, including certification that concrete masonry unit complies with Contract Documents. Include instructions for handling, storage, installation and protection of each type of concrete masonry unit.
- b. Colored Mortar: Technical data on each type of colored mortar, including range of color that can be expected in the Work.

3. Samples: Submit the following:

- a. Color Sample board, for each type of unit masonry specified, showing standard and custom colors.
- b. Each type of unit masonry specified in colors selected by ENGINEER. Select each type of unit masonry to show range of color and texture that can be expected in the Work.
- c. Colored Mortar Samples: Submit complete selection of standard colors and custom colors of mortar for final selection by ENGINEER. Label Samples to indicate type and amount of colorant used.
- d. ENGINEER's review will be for color and texture only.

B. Informational Submittals:

1. Source Quality Control Submittals: Submit the following:

- a. Pre-construction laboratory test results, in accordance with ASTM C140.

2. Test and Evaluation Reports
 - a. Preconstruction testing results as specified in Paragraph 3.01.B of this Section.
3. Qualification Statements:
 - a. Testing laboratory.
 - b. Installer.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Storage of Materials:
 1. Maintain temperatures under cover so that masonry products are above 20 degrees F during installation.

1.06 JOB CONDITIONS

- A. Temporary Facilities: Provide supplemental heat sources and equipment as required should CONTRACTOR desire to continue unit masonry Work in cold weather. Pay for fuel for supplemental heat.
- B. Environmental Requirements:
 1. Do not perform unit masonry Work when air temperature is below 28 degrees F on a rising temperature, or below 36 degrees F on falling temperatures without providing temporary, heated enclosures, or without providing temporary heating or other precautions to prevent freezing.
 2. Do not use frozen products, and do not build upon frozen unit masonry Work.
 3. Remove and replace all unit masonry Work damaged by cold.
- C. Protection:
 1. Protect unit masonry Work against freezing for at least 48 hours after being placed.
 - a. For Mean Daily Air Temperatures of 40 degrees F to 32 degrees F: Protect unit masonry construction from precipitation for 48 hours after installation.
 - b. For Mean Daily Air Temperatures of 32 degrees F to 25 degrees F: Completely cover unit masonry construction for 48 hours after installation.
 - c. For Mean Daily Temperatures of 25 degrees F to 20 degrees F: Completely cover unit masonry construction with insulating blankets for 48 hours after installation of the masonry.
 - d. For Mean Daily Air Temperatures of 20 degrees F and Below: Maintain unit masonry construction above 32 degrees F for 48 hours by enclosure and supplementary heating.
 2. When Work is not in progress, protect partially completed unit masonry construction against rapid heat loss and from water entering the masonry by covering the top of walls with a strong, waterproof, non-staining membrane. Extend the membrane at least two feet down both sides of wall and secure in place using wall cover clamps spaced at intervals of four feet and at each end, and at joints in membrane.

D. Cold Weather Unit Masonry Construction:

1. Mortar used in unit masonry construction when mean daily temperature is below 40 degrees F shall be Portland cement-lime-sand mortar using high early strength Portland cement.
2. Clay or shale unit masonry with suctions in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to installation. Provide water temperature above 70 degrees F when temperature of masonry units is above 32 degrees F. Water temperature shall be above 120 degrees F when temperature of masonry units is below 32 degrees F.
3. For Air Temperatures of 40 degrees F to 32 degrees F: Heat sand or mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
4. For Air Temperatures of 32 degrees F to 25 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
5. For Air Temperatures of 25 degrees F to 20 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F. Provide heat on both sides of the wall under construction. Employ wind breaks when wind is in excess of 15 mph.
6. For Air Temperatures of 20 degrees F and Below: Heat sand and mixing water to minimum of 70 degrees F and maximum of 160 degrees F. Provide enclosure and auxiliary heat to maintain air temperature above 32 degrees F in the work area. Temperature of masonry units when laid shall not be less than 20 degrees F.

- E. Hot Weather Unit Masonry Work: Protect unit masonry Work by methods acceptable to ENGINEER from direct exposure to wind and sun when surrounding air temperature is 99 degrees F in the shade with relative humidity less than 50 percent.

PART 2 – PRODUCTS

2.01 MORTAR MATERIALS

- A. Portland Cement: Provide the following for Portland cement-lime mortars:

1. ASTM C150, Type I.
2. Use ASTM C150, Type III high-early strength, for laying masonry when air temperature is less than 50 degrees F.
3. Provide nonstaining Portland cement of natural color.

- B. Masonry Cement: Provide the following for masonry cement mortars:

1. ASTM C91 Type S, proportioned to comply with ASTM C270.
2. Maximum Air Content, ASTM C91: 19 percent.
3. Non-staining.

- C. Hydrated Lime: ASTM C207 Type S, or lime putty ASTM C5.

D. Sand Aggregates:

1. ASTM C144, except for joints less than ¼-inch, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White Mortar Aggregates: Provide natural white sand or ground white stone for Portland cement-lime mortars.
3. Colored Mortar Aggregates: Provide ground marble, granite, or other sound stone as required to match the sample approved by ENGINEER for Portland cement-lime mortars.
4. Fine Aggregate for Grout: Sand, ASTM C404, Size No. 1.
5. Coarse Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.

E. Colored Mortar Pigments: Provide the following for Portland cement-lime mortars:

1. Commercial iron oxide, manganese dioxide, ultramarine blue, chromium oxide, or carbon black, compounded for use in mortar mixes.
2. Do not exceed pigment to cement ratios, by weight, of one-to-35 for carbon black, and one-to-seven for other pigments.
3. Products and Manufacturers: Provide one of the following:
 - a. True-Tone Mortar Colors by Davis Colors, a Subsidiary of Rockwood Pigments, Inc.
 - b. SGS Concentrated Mortar Colors by Solomon Colors.
 - c. Or approved equal.
4. ENGINEER will select color of mortar.

F. Ready-mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified for mortar materials, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C270 and C387.

G. Water: Free from injurious amounts of oils, acids, alkalis, or organic matter, and clean, fresh, and potable.

2.02 MORTAR MIXES

A. General:

1. Anti-freeze Admixture or Agents: Not allowed.
2. Calcium Chloride: Not allowed.

B. Mortar for Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified in this Section, do not substitute ASTM C91 masonry cement for ASTM C150 Portland cement without a submittal approval by ENGINEER.

C. Grout:

1. Fine Grout:

a. Provide the following proportions by volume:

- 1) Portland Cement: One part.
- 2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
- 3) Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.

b. Mix grout to have a slump of ten inches plus or minus one-inch at placement.

2. Coarse Grout:

a. Provide the following proportions by volume:

- 1) Portland Cement: One part.
- 2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
- 3) Fine Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.
- 4) Coarse Aggregate Ratio: Not less than one and not more than two times sum of volumes of cement and lime.

b. Mix grout to have slump of ten inches plus or minus one-inch, at placement.

2.03 CONCRETE MASONRY UNITS

A. General: Concrete masonry units shall comply with requirements below.

B. Hollow and Solid Load-bearing Concrete Masonry Units: ASTM C90, with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of concrete mix.

C. Hollow Non-load-bearing Concrete Masonry Units: ASTM C129 with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of the concrete mix.

D. Weight:

1. Provide normal weight units using concrete aggregates complying with ASTM C33 producing dry net weight of not less than 125 pounds per cubic foot.

E. Size: Manufacturer's standard units with nominal face dimensions of 16 inches long by eight inches high by nominal width dimension shown on Drawings (15-5/8-inches by 7-5/8-inches actual).

F. Special Shapes: Provide the following:

1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, pre-molded control joint blocks, headers, and other special conditions.

2. Bullnose units for outside vertical corners including doors, windows, louvers and other openings, unless specifically shown by note indicating that this feature is not required.
 3. End blocks at all locations where masonry walls abut concrete, or steel columns to facilitate installation of compressible filler, backer rod and sealant.
- G. Waterproofing Admixture: Manufacture all types of concrete unit masonry, used in construction of exterior walls (including interior wythe of cavity walls) with an integral waterproofing admixture as follows:
1. Material: Cross-linking acrylic polymer.
 2. Proportion: In strict accordance with manufacturer's instructions.
 3. Products and Manufacturers: Provide products of one of the following:
 - a. Dry-Block System by Forrer Industries, a Unit of W. R. Grace & Company Construction Products Division.
 - b. Eucon Blocktite by Euclid Chemical Company.
 - c. Or approved equal.
- H. Exposed Faces: Provide manufacturer's standard and custom colors and textures as specified for type of concrete masonry unit.
- I. Provide two-core concrete masonry units.

2.04 BRICK

- A. Face Brick to Match Existing: Match custom color, texture and size of existing face brick of existing buildings on site, and comply with requirements of ASTM C216, Grade SW for type required. If matching brick of this grade is not available, submit to ENGINEER for approval custom manufactured samples that match existing face brick.

2.05 MASONRY ACCESSORIES

- A. Continuous Horizontal Wire Reinforcing and Ties for Masonry: Provide the following unless otherwise shown:
1. General: Welded wire units prefabricated in straight lengths of not less than ten feet, with matching corner "L" and intersection "T" units. Fabricate from cold-drawn steel wire complying with ASTM A82, with deformed continuous 3/16-inch gage side rods and plain 9 gage cross rods, crimped for cavity wall construction, with unit width of 1.5 to two inches less than thickness of wall or partition. All reinforcing and ties shall be hot dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153, Class B-2, unless otherwise specified.
 2. Multi-wythe Masonry Cavity Walls:
 - a. Double-loop wall reinforcing and support system that maintains minimum one-inch in-plane vertical and horizontal adjustability while providing lateral force resistance required for seismic zone shown.

- b. Welded-closed, upward facing, double vertical loop ties with single pair of side rods in interior wythe, and adjustable, rectangular pintle box ties with parallel overlapping ends, spaced not more than 16 inches on centers. Space side rods for embedment in each face shell wall of back up wythe and extend double-loop ties to allow engagement of rectangular pintle box tie snap-locked to seismic resistance clips and for proper embedment in facing wythe.
 - c. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each box tie, 3/16 inches high with four horizontal snap-tight connection grooves, one accommodating nine gage wire and three accommodating 3/16-inch diameter wire.
 - d. Continuous, nine gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry cavity wall.
 - e. High-impact plastic, mechanical, cavity wall insulation restraint washers, one per double loop-lock tie.
 - f. Products and Manufacturers: Provide products of one of the following:
 - 1) Lox-All #180 S.I.S Dub'l Loop-Lok Truss 187-A Seismic Interlock System with Loop-Lok Washers by Hohmann & Barnard, Inc.
 - 2) DA 3700 S – Seismic Dur-O-Eye; DA 213 QT Lite Duty Seismic Pintel; DA 8706– Pencil Rod; with Shear Lungs by Dur-O-Wal, a Division of Dayton Superior.
 - 3) Or approved equal.
- B. Anchoring Devices for Masonry: Provide the following, unless otherwise shown:
- 1. General: Provide the following:
 - a. Cold rolled steel sheet complying with ASTM A1008, hot-rolled steel sheet and strip complying with ASTM A1011, plates and bars complying with ASTM A36 and cold drawn steel wire complying with ASTM A82, all hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.
 - b. Rectangular, corrugated, one-inch wide ties, fabricated of 16-gage sheet metal at Glazed Structural Clay Tile, unless otherwise specified.
 - c. Size tie lengths to extend to within one-inch of outside face of outer wythe face shell of opposite face of masonry or to maximum depth of 12 inches and between 1.5 inches to two inches less than width of masonry abutting webs and to a maximum depth of 12 inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.
 - d. Flexible Anchors: When masonry abuts structural walls or framework provide flexible anchors that allow horizontal and vertical movement of masonry, but provide lateral restraint.
 - 2. Weep Holes and Vents:
 - a. Provide polyvinylchloride ventilator type weeps.
 - b. Provide regular size, brown finish.

- c. Product and Manufacturer: Provide products of one of the following:
 - 1) No. 85 Cell Vents for Brick and Block by Heckmann Building Products
 - 2) QV-Quadro-Vent for Brick and Block by Hohmann & Barnard, Inc.
 - 3) No. 3601 Cell Vents for Brick and Block by Wire-Bond.
 - 4) Or approved equal.
- 3. Cavity Fill Mesh:
 - a. Monofilament screen of polypropylene polymers, 1/4-inch mesh hardware cloth.
 - b. Install below all block courses that are to be filled with mortar.
 - c. Products and Manufacturers: Provide products of one of the following:
 - 1) No. MGS-Mortar/Grout Screen by Hohmann & Barnard, Inc.
 - 2) No. 267 Plastic Mesh Wall Tie by Heckmann Building Products.
 - 3) DA 1015 Dur-O-Stop by Dur-O-Wal, a Dayton Superior Company.
 - 4) Or approved equal.
- 4. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, or as shown. Provide the following:
 - a. Polyurethane foam strip saturated with polybutylene waterproofing material which, when installed at a compression ratio of two-to-one, is impermeable to water.
 - b. Resilient to -40 degrees F with 100 percent movement recovery.
 - c. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.
 - d. Products and Manufacturers: Provide products of one of the following:
 - 1) Polytite Standard by Polytite Manufacturing Corporation.
 - 2) Polyseal by Sandell Manufacturing Company, Inc.
 - 3) Or approved equal.
- C. Miscellaneous Masonry Accessories: Provide the following, where shown:
 - 1. Reinforcing Bars:
 - a. Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18 except as otherwise shown.
 - 2. Rebar Positioners: Provide the following:
 - a. Nine-gage reinforcing bar positioners that accommodate both horizontal and vertical reinforcing steel.

- b. Fabricate units as required for the Work.
- c. Products and Manufacturers: Provide products of one of the following:
 - 1) #RB Series and #RB-Twin Series Rebar Positioners by Hohmann & Barnard, Inc.
 - 2) Rebar Positioners by Heckmann Building Products.
 - 3) Or approved equal.
- 3. Masonry Control Joint Components: Provide the following:
 - a. Pre-molded Control Joint Strips: Provide complete selection of solid extruded rubber and PVC strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240 and D2287, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
 - 1) Products and Manufacturers: Provide products of one of the following:
 - a) #RS-8" - Control Joints by Hohmann & Barnard, Inc.
 - b) #352-12 Control Joints by Heckmann Building Products.
 - c) Or approved equal.
- 4. Cavity Drainage Material:
 - a. Manufactured of high density polyethylene or nylon strands woven into a 90 percent open mesh.
 - 1) Products and Manufacturers: Provide precuts of one of the following:
 - a) Mortar net by Hohmann and Barnard, Inc.
 - b) MortarNet by Heckmann Building Products.
 - c) Or approved equal.

2.06 SOURCE QUALITY CONTROL

- A. Allowable Tolerances: For concrete masonry units provide the following:
 - 1. Face Dimension: Total variation in finished and installed face dimensions of units shall not exceed 1/16-inch between largest and smallest units in each lot of units of each size.
 - 2. Distortion: Distortion of plane and edges of face of individual units, as installed, from corresponding plane surface and edges of prefaced concrete masonry unit, shall not exceed 1/16-inch.
 - 3. Hand Sort and Match Pre-Faced Concrete Units: Pre-faced concrete masonry units that exceed specified allowable tolerances will be rejected. Pre-faced concrete masonry units inadvertently installed that exceeds allowable tolerances specified shall be removed and new units provided.

PART 3 – EXECUTION

3.01 INSPECTION

- A. CONTRACTOR and installer shall examine areas and conditions under which unit masonry construction Work will be installed and notify ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Preconstruction Testing: Testing agency shall perform tests prior to installation of unit masonry. Special inspections testing procedures are specified in the referenced standards and the Contract Documents.
 - 1. Mortar Test: For each mix required, per ASTM C780.
 - 2. Grout Test: For each mix required, per ASTM C1019 and ACI 530.1.
 - 3. Prism Test: For each type of construction required, per ASTM C 1314 and ACI 530.1.
 - 4. Compressive strength of completed concrete unit masonry walls shall not be less than 1,500 psi as determined by methods specified in ACI 530.1.

3.02 PREPARATION

- A. Measurement of Mortar Materials:
 - 1. Cement and Hydrated Lime: Batched by the bag.
 - 2. Sand: Batched by volume in suitably calibrated containers, provided proper allowance is made for bulking and consolidation and for weight per cubic foot, of contained moisture.
 - 3. Proportion of Volumetric Mixtures: One 94-pound sack of Portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
 - 4. Shovel measurement: Not allowed.
- B. Mortar Mixing:
 - 1. Type of Mixer: Machine mix in approved mixer in which quantity of water is accurately and uniformly controlled.
 - 2. While mixer is in operation add approximately three-quarters of required water, half the sand, all the cement, then add remainder of sand.
 - 3. Allow batch to mix briefly then add water in small quantities until satisfactory workability is obtained.
 - 4. Mix for at least five minutes after all materials have been added.
 - 5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn over materials for each batch together until even color of mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout mass, then add water to obtain required plasticity.

6. Lime putty, if approved for use, shall be prepared in accordance with ASTM C5.
7. Mixer drum shall be completely emptied before recharging next batch.
8. Re-tempering of mortar is not allowed.

C. Wetting of Masonry Units:

1. Face Brick: Wet brick having ASTM C67 absorption rates in excess of 30 grams per 30 square inches per minute, so that rate of absorption when laid does not exceed this amount.
 - a. Determine absorption by placing 20 drops of water using a medicine dropper inside one-inch diameter circle on typical units. If water is absorbed within 90 seconds, wet brick before laying.
 2. Use wetting methods that ensure that each masonry unit is nearly saturated but surface-dry when laid.
 3. Concrete Masonry Units: Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.
- D. Cleaning Reinforcement: Before being placed, remove loose rust, mill scale, earth, ice, and other coatings except galvanizing from reinforcement. Do not use reinforcing bars with kinks or bends not shown on Drawings or approved Shop Drawings, or bars with reduced cross-section.

3.03 INSTALLATION, GENERAL

- A. Thickness: Build walls, floors and other unit masonry construction work to thickness shown. Build single-wythe walls to actual thickness of masonry units using units of nominal thickness shown or specified.
- B. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to start of masonry Work. After installing said items, complete unit masonry Work to match Work immediately adjacent to openings.
- C. Cut masonry units using wet cutting, motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible.
- D. Match Existing Masonry: Match coursing, pattern bond, color, texture and size of new unit masonry with adjacent, existing masonry.

3.04 LAYING MASONRY WALLS

A. General:

1. Mortar Types: Unless otherwise indicated, use mortar as specified and as follows:
 - a. For all Work, use Type S mortar.
 - b. Use coarse grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction Work.
 - c. Do not use mortar that has begun to set or if more than 30 minutes have elapsed since initial mixing. Re-temper mortar during the 30-minute period only as required to restore workability.

2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns, and offsets. Avoid using less than half-size units at corners, jambs, and where possible at other locations.
3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced, and coordinated with other Work.
4. Pattern Bond Unit Masonry:
 - a. Lay all unit masonry Work visible in the finished Work in to match existing. Avoid using less than full-size units.
 - b. Bond and interlock each course of each wythe at corners.
 - c. Do not use units with less than eight-inch horizontal face dimensions at corners or jambs when possible.
 - d. Interlock alternate courses at corners.
5. Color of Concrete Unit Masonry:
 - a. Lay all concrete unit masonry of natural color.

B. Construction Tolerances:

1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in 10 feet, or 3/8-inch in a story height (20 feet maximum), nor two-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, nor two-inch in 40 feet or more.
2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed two-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
4. Variation in Cross-sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus two-inch.

C. Mortar Bedding and Jointing:

1. Lay solid masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
2. Lay hollow masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
 - a. Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment. Lay walls with 3/8-inch joints.
3. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.

4. Tool exposed joints, when mortar is "thumbprint" hard, slightly concave. Rake out mortar in preparation for application of calking or sealants where required.
 5. Concave-tool exterior joints below grade.
 6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
- D. Stopping and Resuming Work: Rake back half-unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.
- E. Built-in Work:
1. As the Work progresses, build in items shown, specified or required by others. Fill cores in one block width solidly with masonry around built-in items.
 2. Where built-in items are to be embedded in cores of hollow masonry units, place layer of cavity fill mesh in joint below and rod mortar or grout into core.
- F. Horizontal Joint Reinforcing:
1. Provide continuous horizontal joint reinforcing as specified. Fully embed longitudinal side rods in mortar for their entire length with minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcement minimum of six inches at ends of units. Do not bridge masonry control joints with reinforcing.
 2. Reinforce all masonry walls with continuous horizontal joint reinforcing unless specifically noted or specified to be omitted.
 3. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend units in accordance with manufacturer's written instructions.
 4. Space continuous horizontal reinforcing as follows:
 - a. Space reinforcing at 16 inches on centers vertically, unless otherwise shown.
 5. Reinforce masonry openings greater than 12 inches wide, with horizontal joint reinforcing placed in two horizontal joints approximately eight inches apart, immediately above lintel and immediately below sill. Extend reinforcing minimum of 2.0 feet beyond jambs of opening.
 6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the Contract Documents.
- G. Structural Bonding of Multi-wythe Masonry:
1. Use continuous reinforcing embedded in horizontal mortar joints for bond tie between wythes as specified in this Section.
 2. Corners: Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.
 - a. For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units as specified in this Section, in addition to masonry bonding.

3. Intersecting and Abutting Walls: Unless vertical expansion or masonry control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space as follows:
 - a. Provide masonry bond in alternate courses.
 - b. Provide individual metal ties at not more than 2.0 feet on centers vertically, unless shown at closer spacing.
 - c. Provide continuity with horizontal joint reinforcing using prefabricated "T" and "L" units.

H. Cavity Walls:

1. Determine that bituminous dampproofing is installed (refer to Section 07111, Bituminous Dampproofing).
2. Position insulation as shown and per Section 07210, Building Insulation.
3. Install cavity drainage material.
4. Keep cavity clean of mortar droppings during construction by using continuous horizontal board same width as cavity with lifting wires at each end. Board upward before placing horizontal joint reinforcement. Clean mortar droppings from board. Do not clean into cavity. Joints facing cavity shall be struck flush.
5. Tie exterior wythe to masonry back-up with truss and tab-type continuous horizontal wire reinforcing with individual adjustable hook-type box ties spaced no more than 16 inches on centers vertically and 2.0 feet on centers horizontally. Stagger in alternate courses. Refer to Article 2.6 of this Section for type of ties required.
6. Tie exterior wythe to concrete back-up with individual dovetail anchors spaced no more than 16 inches on centers vertically and 2.0 feet on centers horizontally. Stagger in alternate courses. Refer to Article 2.6 of this Section for type of anchors required.
7. Provide weeps in exterior wythe of cavity wall, in all wall foundation courses and immediately above ledges and flashing, spaced 2.0 feet on centers, unless closer spacing is shown. Place weeps sequentially when laying masonry. Keep weep holes free of mortar and other obstructions.

I. Structural Reinforced Unit Masonry Construction:

1. Comply with the requirements of ACI 530.1 and applicable codes.

J. Grouting Structural Reinforced Unit Masonry Construction:

1. Comply with requirements of ACI 530.1 and applicable codes.

K. Anchoring Masonry Work:

1. Provide anchoring devices of type specified. If not shown or specified, provide standard type for facing and back up involved in compliance with requirements of Laws and Regulations.

2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
 - a. Provide an open space not less than 1/2-inch or more than one-inch in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar and other rigid materials.
 - b. Anchor masonry to cast-in-place concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips and with triangular ties fitted with flexible dovetails for anchorage to cast-in-place concrete.
 - c. Space anchors as shown, but not more than 2.0 feet on center vertically and 3.0 feet on center horizontally.
 - d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, firesafing insulation, backer rod, and sealant.

L. Flashing of Masonry Work:

1. Provide concealed flashings and drip edges in masonry Work as shown. Refer to Section 07650, Flexible Masonry Flashing, for type of flashing and drip edge required. Prepare masonry surfaces smooth and free from projections which might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing two inches from face of wall, unless otherwise shown. Extend flashing at steel lintels in opening heads and turn down.
 - a. Extend flashings beyond edge of lintels and sills at least 4 inches and turn up edge on sides, to form pan (end dam), to direct moisture to exterior.
 - b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1.5 inches and seal lap with elastic sealant.
 - c. Seal joints in through wall metal flashing water tight.
 - d. Install flashings in accordance with manufacturer's instructions.
2. Install reglets and nailers for flashing and other related work where shown to be built into unit masonry construction Work.

3.05 REPAIR, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent Work to provide neat, uniform appearance, properly prepared for application of sealant compounds.
- C. Cleaning Exposed, Unglazed Masonry Surfaces:
 1. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain ENGINEER's acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
 - a. Dry-clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.

- b. Presoak wall by saturating with water and flush off loose mortar and dirt.
 - c. Comply with requirements and recommendations for "Cleaning Clay Products Masonry" of Technical Notes on Brick and Tile Construction by Brick Industry Association for type of masonry and conditions involved in the Work.
 - d. Apply cleaners per manufacturer's instructions.
 - e. Protect other Work from cleaning solutions and cleaning operations.
2. Do not use acid cleaning agent, abrasive tools or powders, or metal cleaning tools or wire brushes, unless specifically recommended in writing by manufacturer.
- D. Protection:
- 1. Protect unit masonry construction Work from deterioration, discoloration or damage during subsequent construction operations.

3.06 FIELD QUALITY CONTROL

- A. CONTRACTOR shall hire independent testing laboratory acceptable to ENGINEER to take samples and conduct tests to evaluate air entrainment, water retention, and compliance of products with Contract Documents, and to determine compressive strength of mortar and grout. Conduct tests in accordance with ASTM C91. Provide tests results to ENGINEER prior to commencement of Work.
- B. After initial test, ENGINEER will require maximum of five additional tests to be conducted at his discretion.
- C. Test and inspect all non-load-bearing concrete unit masonry during construction, meeting requirements of Level 2 Quality Assurance as defined by ACI 530.1.
- D. Test and inspect all load-bearing concrete unit masonry during construction, meeting the requirements of Level 3 Quality Assurance as defined by ACI 530.1.
- E. Masonry walls that do not meet requirements of Special Inspections shall be repaired in manner acceptable to ENGINEER at no expense to OWNER.

END OF SECTION 04005

NO TEXT ON THIS PAGE

SECTION 05051
ANCHOR SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ACI 318, Building Code Requirements for Structural Concrete.
2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.
5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
10. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.

13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
15. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
17. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
21. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
22. FS A-A-1923A, Concrete Expansion Anchors.
23. FS A-A-1925A, Shield, Expansion (Nail Anchors).
24. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
25. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
26. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
27. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
2. Professional Engineer:
 - a. CONTRACTOR or delegated system manufacturer shall retain a registered professional engineer legally qualified to practice in the same state as the Site.

b. Responsibilities include:

- 1) Reviewing anchor system performance and design criteria stated in the Contract Documents.
- 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
- 3) Preparing or supervising preparation of design calculations and related Shop Drawings.
- 4) Signing and sealing all design calculations and Shop Drawings.
- 5) Certifying that:
 - a) Design of anchor systems has been performed in accordance with performance and design criteria stated in the Contract Documents, and
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.

2. Post-installed Anchor Installer: Shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.

1.04 SUBMITTALS

A. Submittals and formatting shall be in accordance with Section 01330 Submittals.

B. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.

2. Product Data:

- a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
- b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.

C. Delegated Design Submittals:

1. Design Data: Submit the following:

- a. Design Calculations for delegated anchor systems. Structural calculations shall include all specified performance criteria. The magnitude of delegated system/anchorage reactions to supporting structure shall be clearly noted. Design calculations shall be signed, sealed and dated by CONTRACTOR's professional engineer.

D. Informational Submittals: Submit the following:

1. Certificates:

- a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
- b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
- c. For each required adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.

2. Manufacturer's Instructions:

- a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).

3. Field Quality Control Submittals:

- a. Submit results of field quality control testing and inspections performed by testing laboratory.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Keep materials dry during delivery and storage.
2. Store adhesive materials within manufacturer's recommended storage temperature range.
3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. General:

1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
2. Stainless Steel Nuts:
 - a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.

- b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
- 3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria

- 1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
 - a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
 - b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.
 - 1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.
 - 2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.
 - 3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
 - 5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

- 6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.
3. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents. Anchor system shall be designed by a professional engineer, retained by CONTRACTOR, Subcontractor, or Supplier, registered in the same state as the Site, with proper consideration of concrete strength, spacing and edge distance.
 - a. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
 - 1) Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
 - 2) Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
 - 3) Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.

C. Application:

1. Anchor Bolts:
 - a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
 - b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
2. Concrete Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Suitable for use in submerged, intermittently submerged, or buried locations.
 - e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
 - f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.

3. Concrete Masonry Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
4. Concrete Wedge Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation in concrete.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
 - d. Do not use in submerged, intermittently submerged, or buried locations.
 - e. Suitable for use in overhead applications.
5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
 - b. Do not use where subject to vibration.
 - c. Do not use in exterior locations or locations subject to freezing.
6. Hollow Concrete Masonry Sleeve Expansion Anchors:
 - a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
 - a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use where subject to vibration.
 - d. Do not use at submerged, intermittently submerged, or buried locations.

- e. Do not use in exterior locations or locations subject to freezing.
 - f. Suitable for use in overhead applications.
8. Concrete Undercut Anchors:
- a. Use where undercut anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Do not use in submerged, intermittently submerged, or buried locations.
 - d. Do not use in exterior locations or locations subject to freezing.
 - e. Suitable for use in overhead applications.
9. Concrete Inserts:
- a. Use only where shown or indicated in the Contract Documents.
 - b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
10. Drive-In Expansion Anchors:
- a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
 - b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
 - c. Do not use in overhead applications.
11. For Use in Precast Concrete Planks:
- a. To support piping or conduit two-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
 - b. For piping greater than two-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.02 MATERIALS

A. Anchor Bolts:

- 1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 36, with heavy hex nuts complying with ASTM A563 Grade 36, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
- 2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.

3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:

1. General:
 - a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
 - a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
 - b. SET-XP Epoxy-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Adhesive:
 - a. Adhesive system shall use two-component adhesive mix.
 - b. Epoxy adhesives shall comply with physical requirements of ASTM C881/C881M, Type IV, Grade 2 and 3, Class A, B, and C, except gel times.
 - c. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308.
4. Anchor:
 - a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Masonry Adhesive Anchors:

1. General:
 - a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
 - b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.

2. Products and Manufacturers: Provide one of the following:
 - a. HIT-HY 70 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
 - b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Adhesive:
 - a. Adhesive system shall use two-component adhesive mix.
 - b. Hybrid adhesives shall comply with the following:
 - 1) ASTM D695 compressive yield strength greater than 7,200 psi on a seven-day cure.
 - c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58 and ICC-ES AC 60.
4. Anchor:
 - a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube (for hollow masonry applications):
 - a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.

D. Concrete Wedge Expansion Anchors:

1. General:
 - a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
2. Products and Manufacturers: Provide one of the following:
 - a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
 - b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.

6. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.
- E. Grout-filled Masonry Wedge Expansion Anchors:
1. General:
 - a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
 2. Product and Manufacturers: Provide one of the following:
 - a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
 - b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
 3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
 4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
 5. Other Locations: Provide AISI Type 316 stainless steel anchor, complete with nut and washer, in accordance with ASTM A276 or ASTM A493.
 6. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.
- F. Hollow Concrete Masonry Sleeve Expansion Anchors:
1. General:
 - a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.
 2. Products and Manufacturers: Provide one of the following:
 - a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
 - b. Dynabolt Sleeve Anchors, by ITW Red Head.
 - c. Or approved equal.
 3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
 4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
 5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 316 stainless steel, in accordance with ASTM A276 or ASTM A493.

G. Drop-in Expansion Anchors:

1. General:
 - a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
 - a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
 - b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

H. Concrete Undercut Anchors:

1. General:
 - a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
2. Products and Manufacturers: Provide one of the following:
 - a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
 - b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
 - c. Or approved equal
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

I. Concrete Inserts:

1. Manufacturers: Provide products of one of the following:
 - a. Unistrut Corporation.
 - b. Cooper B-Line, Inc.
 - c. Anvil International, Inc.
 - d. Or approved equal.
2. Spot Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
 - a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
4. Provide inserts with plain finish.

J. Drive-In Expansion Anchors:

1. General:
 - a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
2. Products and Manufacturers: Provide one of the following:
 - a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
 - b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
 - c. Or approved equal.
3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

K. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

L. Anti-Seizing Compound:

1. Products and Manufacturers: Provide one of the following:
 - a. Pure Nickel Never-Seez, by Bostik.
 - b. Nickel-Graf, by Anti-Seize Technology.
 - c. Or approved equal.
2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Anchor Bolts:

1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
3. Protect threads and shank from damage during installation and subsequent construction operations.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:

1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:

1. Comply with manufacturer's written installation instructions and the following.
2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.

5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
 - a. Core drilled holes shall not be allowed.
 - b. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 3,000 psi.
 - c. At time of anchor installation, concrete shall have age of not less than 21 days.
 - d. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
 - e. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
 - f. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 3,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
 - g. Obstructions in drill path: When existing reinforcing steel is encountered during drilling, stop and do not damage existing reinforcing. Obtain ENGINEER approval for any required modifications.

D. Expansion Anchors:

1. Comply with expansion anchor manufacturer's written installation instructions and the following:
2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.

4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:

1. Comply with undercut anchor manufacturer's written installation instructions and the following.
2. Protect threads from damage during anchor installation.
3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
5. Insert the anchor by hand until anchor reaches bottom of hole.
6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
7. Verify that the setting mark is visible on the threaded rod above the sleeve.
8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:

1. Comply with concrete insert manufacturer's installation instructions.
2. Inserts shall be flush with slab bottom surface.
3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:

1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.01.B of this Section.
2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.03 CLEANING

- A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.04 FIELD QUALITY CONTROL

A. Site Tests:

1. OWNER Will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
 - a. Testing shall comply with ASTM E488.
 - b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing, or at ENGINEER's option CONTRACTOR may arrange for testing paid by CONTRACTOR, for all adhesive anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, ENGINEER may require retesting of all anchors of the same diameter and type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
 - c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
 - d. Apply test loads with hydraulic ram.
 - e. Displacement of post-installed anchors shall not exceed $D/10$, where D is nominal diameter of anchor being tested.
2. Mechanical Anchors:
 - a. Responsibility:
 - 1) OWNER Will employ testing agency to perform field quality control tensile testing of mechanical anchors at the Site.
 - 2) CONTRACTOR shall demonstrate competence in installing mechanical anchors by performing field quality control tests.
 - b. Perform field quality control tests on test anchors at location directed by ENGINEER. Test anchors shall not be part of the finished Work.
 - c. Test not less than one installation of each type of mechanical anchor used in the Work.
 - 1) Load each test anchor to failure.
 - 2) Testing shall comply with ASTM E488.
 - 3) Apply test loads with hydraulic ram.
 - d. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to OWNER.
 - e. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
3. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.

4. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.
5. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

B. Manufacturer's Services:

1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

END OF SECTION 05051

SECTION 05120
STRUCTURAL STEEL FRAMING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide professional services, labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural steel framing, including surface preparation and shop priming.
2. Structural steel framing is the Work defined in AISC 303, Section 2, and as shown or indicated in the Contract Documents. The Work also includes:
 - a. Providing openings in and attachments to structural steel framing to accommodate the Work under this and other Sections, and providing for structural steel framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural steel framing Work.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.
3. Section 09900, Painting.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 325, Steel Construction Manual.
3. AISC 360, Specification for Structural Steel Buildings.
4. ASME B46.1, Surface Texture (Surface Roughness, Waviness and Lay).
5. ASTM A6/A6M, Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. ASTM A36/A36M, Specification for Carbon Structural Steel.
7. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
8. ASTM A108, Specification for Steel Bar, Carbon and Alloy, Cold-Finished.

9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
10. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.
11. ASTM A490, Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
12. ASTM A500/A500M, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
14. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
15. ASTM A992/A992M, Specification for Structural Steel Shapes.
16. ASTM E329, for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
17. ASTM F436, Specification for Hardened Steel Washers.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
20. ASTM F1852, Specification for "Twist off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
21. AWS D1.1/D1.1M, Structural Welding Code-Steel.
22. CMAA 74, Specifications for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist.
23. ISO 2859-1, Sampling Procedures for Inspection by Attributes -- Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection.
24. ISO 4017, Hexagon Head Screws -- Product Grades A and B.
25. RCSC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Steel Fabricator:
 - a. Structural steel fabricating plant shall possess current certificate from AISC stating that the fabrication facility complies with requirements for certification of "Standard for Steel Building Structures (STD)" of AISC's quality certification program. Fabricating plant shall maintain this certification throughout time of fabrication for this Project.

2. Welders and Welding Processes:
 - a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, Section 5, Qualification.
 - b. Each welder employed on or to be employed for the Work shall possess current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.
3. Professional Engineer:
 - a. CONTRACTOR or structural steel framing manufacturer shall retain a registered professional engineer legally qualified to practice in the same state as the Site to design steel framing connections as indicated in the Contract Documents.
 - b. Responsibilities include but are not necessarily limited to:
 - 1) Reviewing steel framing connections performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations and related Shop Drawings.
 - 4) Signing and sealing all design calculations and Shop Drawings.
 - 5) Certifying that:
 - a) Design has been performed in accordance with performance and design criteria stated in the Contract Documents, and to prevailing standards of practice.
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
4. Testing Laboratory:
 - a. CONTRACTOR shall retain the services of an independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
 - b. Laboratory shall comply with ASTM E329.
 - c. Testing laboratory shall be experienced in the types of testing required.
 - d. Welding inspection and welding inspector qualifications shall be in accordance with AWS D1.1/D1.1M.
 - e. Selection of testing laboratory is subject to ENGINEER's acceptance.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
 - b. Include complete information for fabrication of the structure's components, including but not limited to location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld. Provide signed and sealed shop drawing and design calculations by a Professional Engineer registered in the state in which the site is located.
 - c. Setting drawings, templates, and directions for installing anchorage devices.
2. Product Data:
- a. Manufacturer's specifications and installation instructions for products listed below.
 - 1) High-strength bolts of each type, including nuts and washers.
 - 2) Welding electrodes and rods.
 - 3) Load indicator bolts and washers.
- B. Delegated Design Submittals:
1. Design Data: Submit the following:
- a. Design Calculations:
 - 1) Complete calculations required for the design of the delegated steel framing connections as one package with the Shop Drawings. Structural calculations shall include all specified performance criteria and design loads used in the design. All calculations and assumptions shall be presented so that ENGINEER can easily follow the progress and logic of CONTRACTOR's professional engineer. The design analysis shall include the name and office phone number of the designer to answer questions during the shop drawing review.
 - b. Design calculations shall be signed, sealed, and dated by CONTRACTOR's professional engineer registered in The Commonwealth of Virginia. Engineer's registration number, and name on seal shall be clearly legible.
- C. Informational Submittals: Submit the following:
1. Certificates.
- a. Fabricator's AISC quality certification.
 - b. Welders' certifications.
 - c. Certified reports of laboratory tests on previously-manufactured, identical materials, and other data as necessary, to demonstrate compliance with the Contract Documents for the materials listed below:
 - 1) Structural steel of each type, including certified mill reports indicating chemical and physical properties.
 - 2) High-strength bolts of each type, including nuts and washers.

2. Supplier Instructions:
 - a. Installation data, handling, and storage instructions.
3. Source Quality Control Submittals:
 - a. When performed or when required by ENGINEER, submit results of source quality control testing and inspections performed at the mill or shop.
4. Field Quality Control Submittals:
 - a. Submit results of testing and inspection performed in the field by testing laboratory employed by CONTRACTOR.
 - b. Written field survey reports for all bearing surfaces surveyed, verifying tolerance requirements, areas out of tolerance, and corrective measures required.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage:

1. Protect steel members and packaged materials from corrosion and deterioration.
2. Do not store materials in or on the building or structure in manner that may cause distortion or damage to structural steel members, building, or supporting structures.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Steel Types:

1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A1085 or ASTM A500, Grade C.
4. Angles, Plates, and Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Anchorages, Fasteners, and Connectors:

1. Anchorage Devices: Refer to Section 05051, Anchor Systems.
2. High-Strength Threaded Fasteners: Heavy hexagonal structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 - a. Unless otherwise indicated, fasteners shall be quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325, Type I, nuts complying with ASTM A563C, A563DH or A194/A194M 2H, and hardened washers complying with ASTM F436. Bolts, nuts and washers shall be hot-dip galvanized where shown or indicated.
 - b. Tension control bolts, when used, shall comply with ASTM F1852.

- c. Compressible washer-type direct-tension indicators, when used, shall comply with ASTM F959, Type 325.
- 3. Threaded Rod: Provide threaded rods with heavy hexagon nuts, and hardened washers, as follows:
 - a. Interior and Dry Locations: Provide threaded carbon steel rods complying with ASTM A36, with heavy hex nuts complying with ASTM A563A, unless otherwise shown or indicated on the Drawings.
 - b. Exterior, Buried, or Submerged Locations, or When Exposed to Wastewater: Provide stainless steel threaded rods complete with washers complying with ASTM F593, AISI Type 316, Condition A, with ASTM A194/A194M, Grade 8S (nitronic 60) stainless steel nuts. Other AISI types may be used when approved by ENGINEER.
- C. Electrodes for Welding: E70XX complying with AWS D1.1/D1.1M.

2.02 FABRICATION

A. Shop Fabrication and Assembly:

- 1. General:
 - a. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC 325, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown or indicated.
 - b. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.
 - c. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.
- 2. Connections:
 - a. The design of framing connections and for any part of the steel framing structure not specifically detailed on the Contract Drawings shall be completed by CONTRACTOR, per AISC 303 - Option 3, under the supervision of a professional engineer registered in the same state as the Site. Design loads are indicated on the Contract Drawings.

B. Connections:

- 1. Shop Connections:
 - a. Unless otherwise shown or indicated, shop connections may be welded or high-strength bolted connections. Welds shall be 3/16-inch minimum.
 - b. Where reaction values of beam are not shown or indicated, connections shall be detailed to support one-half the total uniform load capacity tabulated in tables contained in AISC 325 for allowable loads on beams for the associated shape, span, and steel specified for the beam.
 - c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.

- d. End-connection angles fastened to webs of beams and girders, and the thickness of angles, size, and extent of fasteners or shop welds, shall comply with tables of "Framed Beam Connections" in AISC 325. Connections shall be two-sided, unless otherwise shown or indicated.
 - 2. Field Connections:
 - a. Field connections, unless otherwise shown or indicated, shall be made with high-strength bolts, and shall be bearing-type connections.
 - b. Use field welding only where shown or indicated or where approved by ENGINEER. Welds shall be 1/4-inch minimum.
 - 3. High-Strength Bolted Construction:
 - a. Provide high-strength threaded fasteners in accordance with RCSC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.
 - b. High-strength bolt design shear values shall be as specified in AISC 325 for bolts with threads in the shear plane for bearing type connections, or as specified in this Section for slip-critical connections.
 - c. Bolted connections shown or indicated as "SC" shall comply with slip-critical connection requirements in RCSC Specifications for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
 - 1) Faying surfaces shall have a Class A surface condition.
 - 2) Slip-critical bolts shall be fully pre-tensioned to 70 percent of minimum specified tensile strength of the bolt using one of the following methods:
 - a) Turn of nut with matchmarking.
 - b) Twist-off tension control bolt (ASTM F1852).
 - c) Direct tension indicator washer (ASTM F959).
 - d. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.
 - 4. Welded Construction: Comply with AWS D1.1/D1.1M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.
 - 5. Where rigid connections are required by stresses shown or indicated, provide web shear reinforcement and stiffeners in accordance with AISC 360.
- C. Bracing:
- 1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.
 - 2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.
 - 3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.
 - 4. Gussets shall be not less than 3/8-inch thick, unless otherwise shown or indicated.

- D. Columns: Column shafts shall have finished bearing surface roughness not greater than 500 micro-inch in accordance with ASME B46.1, and ends shall be square within tolerances for milled ends in accordance with ASTM A6/A6M at the base and at splice lines.
- E. Structural Tubing: Properly seal structural tubing to protect internal surfaces.
- F. Holes and Appurtenances for Other Work:
 - 1. Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on the approved Shop Drawings. If large block-outs are required and approved, reinforce the webs to develop specified shears. Provide threaded nuts welded to framing and other specialty items as shown or indicated to receive other work.
 - 2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

2.03 FINISHING

- A. Surface Preparation and Shop Priming: Structural steel shall be primed in the shop. For surface preparation and shop priming requirements refer to Section 09900, Painting.

2.04 SOURCE QUALITY CONTROL

- A. Inspection and Testing at the Mill or Shop:
 - 1. Perform fabricator's standard procedures for source quality control, including inspections and testing.
 - 2. Materials and fabrication procedures shall be subject to inspection and tests in mill and shop, conducted by a qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 ERECTION

- A. General: Comply with AISC 303, AISC 360, and the Contract Documents.
- B. Checking of Lines and Elevations: Before proceeding with structural steel erection, furnish services of a qualified surveyor to check lines and elevations of concrete and masonry bearing surfaces, and locations of anchorage devices and similar devices. Immediately report discrepancies to ENGINEER. Do not proceed with erection until defective Work that will support structural steel is corrected, including agreeing with ENGINEER upon compensating adjustments (if any) to structural steel Work.
- C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy-lines to achieve proper alignment of structures as erection proceeds.

D. Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete the Work. Provide sufficient planking to comply with Laws and Regulations and provide tightly-planked substantial floor within two stories or 30 feet, whichever is less, below each tier of steel beams on which work is performed.

E. Anchorage Devices:

1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural steel to foundations and other in-place construction.
2. Provide templates and other devices necessary for presetting anchorage devices to accurate locations.
3. Refer to Section 05051, Anchor Systems, for anchorage requirements.

F. Setting Bases and Bearing Plates:

1. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
2. Set loose and attached base plates and bearing plates for structural members on steel wedges or other adjusting devices.
3. Tighten anchorage devices after supported members are positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
4. Place grout between bearing surfaces and bases or plates. Finish exposed surfaces, protect installed materials, and allow to cure in accordance with grout manufacturer's instructions, and as otherwise required.
5. Do not use leveling plates or wood wedges.

G. Field Assembly:

1. Set structural frames accurately to the lines and elevations shown and indicated. Align and adjust the various members forming part of a complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
2. Level and plumb individual members of structure within tolerances as specified in AISC 325. For members requiring accurate alignment, provide clip angles, lintels, and other members, with slotted holes for horizontal adjustment at least 3/8-inch in each direction, or more when required.
3. Splice members only where shown or indicated.

H. Erection Bolts: On exposed-to-view, welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

I. Connections:

1. Comply with AISC 325 for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.

2. Do not enlarge inadequate holes in members by burning or by using drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- J. Gas Cutting: Do not use gas-cutting torches for correcting fabrication defects in structural framing. Cutting will be allowed only on secondary members that are not under stress, as approved by ENGINEER. Finish gas-cut sections equal to a sheared appearance, when allowed.
- K. Touch-up Painting:
1. Unless otherwise specified, comply with touch-up painting requirements in Section 09900, Painting.
 2. Immediately after erection, clean field welds, bolted connections, and damaged or abraded areas of shop-applied paint. Apply paint to exposed areas with the same paint or coating material applied in the shop. Apply by brush or spray to provide not less than the dry film thickness specified in Section 09900, Painting.

3.03 FIELD QUALITY CONTROL

- A. Site Tests and Inspections: Materials and erection procedures shall be subject to inspection and tests at the Site conducted by qualified inspection laboratory. Such inspections and tests do not relieve CONTRACTOR of responsibility for providing the Work in accordance with the Contract Documents.
1. Engage independent testing and inspection laboratory to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.
 - a. Testing laboratory shall conduct and interpret tests, prepare and state in each report of results whether test specimens comply with the Contract Documents and specifically indicate all deviations.
 - b. High-strength Bolted Connections: Each high-strength bolted connection shall be visually inspected. Inspection shall identify whether the Work complies with Sections 2, 3, and 8 of RCSC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
 - 1) For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning.
 - 2) For connections that are not slip critical and not subject to direct tension, bolt does not need to be inspected for bolt tension, but shall be visually inspected to verify that plies of connected elements are in snug contact.
 - 3) Where bolts or connections are defective, correct defective workmanship, remove and replace, or correct as required defective bolts and connections. CONTRACTOR shall pay for correcting defective Work and tests required to confirm integrity of corrected Work.
 - c. Welds: Each weld shall be visually inspected.
 - 1) Where visually defective welds are evident, further test welds using non-destructive methods. If welds are determined to be acceptable, OWNER will pay for non-destructive testing. When welds are defective, CONTRACTOR shall pay for non-destructive testing.

- 2) Correct, or remove and replace, defective Work as directed by ENGINEER.
- 3) CONTRACTOR shall pay for corrections and subsequent tests required to determine weld compliance with the Contract Documents.

END OF SECTION 05120

NO TEXT ON THIS PAGE

SECTION 05501

MISCELLANEOUS METAL FABRICATIONS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
2. The Work also includes:
 - a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections, and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the Work to be installed with, or attached to miscellaneous metal fabrications Work.
2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 03005, Concrete.
3. Section 05051, Anchor Systems.
4. Section 09900, Painting,

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
3. ASTM A36/A36M, Specification for Carbon Structural Steel.
4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
9. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
10. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
12. ASTM A793, Specification for Rolled Floor Plate, Stainless Steel.
13. ASTM A992/A992M, Specification for Structural Steel Shapes.
14. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
15. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
16. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
20. AWS D1.1/D1.1M, Structural Welding Code – Steel.
21. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
22. AWS D1.6, Structural Welding Code – Stainless Steel.
23. NAAMM, Metal Finishes Manual.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Welding:
 - a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
 - b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

2. Professional Engineer:

- a. CONTRACTOR or miscellaneous metals manufacturer shall retain a registered professional engineer legally qualified to practice in same state as the Site. Professional engineer shall have at least five years' experience.
- b. Responsibilities include:
 - 1) Reviewing miscellaneous metal system performance and design criteria stated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising preparation of design calculations verifying compliance of fabrication system with requirements of the Contract Documents.
 - 4) Signing and sealing all calculations.
 - 5) Signing and sealing all shop drawings.
 - 6) Certifying that:
 - a) Design of miscellaneous fabrication was performed in accordance with performance and design criteria stated in the Contract Documents, and
 - b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.

B. Regulatory Requirements: Conform to the following:

- 1. 29 CFR 1910, Occupational Health and Safety Standards.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices. Provide signed and sealed shop drawing and design calculations by a Professional Engineer registered in the state in which the miscellaneous metal work will be installed and is a recognized expert in the type of Work shown and specified.
- 2. Product Data:
 - a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.

B. Informational Submittals: Submit the following:

1. Test and Evaluation Reports:
 - a. Mill test report that indicate chemical and physical properties of each type of material, when requested by ENGINEER.
2. Qualifications Statements:
 - a. Copies of welder's certifications, when requested by ENGINEER.
3. Delegated Design Submittals:
 - a. Design computations signed and sealed by professional engineer. Professional engineer's seal shall be clearly legible, including state of registration, registration number, and name on seal.
 - b. Certification by professional engineer that professional engineer has performed design in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to all local, state, and federal Laws and Regulations, and to prevailing standards of practice.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Steel:

1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A500, Grade B.
4. Angles, Plates, Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Aluminum:

1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

C. Stainless Steel:

1. Plates and Sheets: ASTM A240/A240M, Type 316 stainless steel.
2. Submerged or Intermittently Submerged: Type 316 stainless steel.
3. Non-submerged: Type 316 stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 316 Stainless Steel.

E. Zinc-coated Hardware: ASTM A153/A153M.

2.02 MISCELLANEOUS METAL ITEMS

A. Shop Assembly:

1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Steel Lintels:

1. Provide loose structural steel lintels for openings and recesses in masonry walls and brick walls as specified or as shown.
2. Weld adjoining members together to form a single unit, where shown or indicated.
3. Provide not less than eight inches bearing at each side of openings, unless otherwise shown.
4. Steel lintels to be installed in exterior walls shall be hot-dip galvanized and finish painted. Other steel lintels shall be painted.
5. Surface preparation and painting shall conform to Section 09900, Painting.

C. Shelf Angles:

1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
 - a. Provide galvanized shelf angles on outdoor construction.
2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

D. Aluminum Stair Nosings:

1. Manufacturers: Provide products of one of the following:
 - a. Supergrit Type 241BF by Wooster Products, Inc.
 - b. Or approved equal.

2. Fabricate extruded aluminum nosing of sizes and configurations as shown on the Drawings.
 - a. Unless otherwise shown, provide ribbed abrasive filled type, using black abrasive filler.
3. Provide anchors for embedding in concrete, either integral or applied to treads, as standard with manufacturer.

E. Miscellaneous Framing and Supports:

1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.
2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
 - a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
 - b. Galvanize exterior miscellaneous frames and supports.
 - c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.
7. Surface preparation and painting of galvanized surface shall conform to Section 09900, Painting

F. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.

G. Anchors and Expansion Anchors: Refer to Section 05051, Anchor Systems.

2.03 FINISHING

A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09900, Painting.

B. Galvanizing:

1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.

C. Aluminum Finish: Provide natural mill finish for aluminum Work unless otherwise shown or specified.

2.04 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine conditions under which the Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.
- B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.
- C. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- D. Protection of Aluminum from Dissimilar Materials:
1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09900, Painting.

END OF SECTION 05501

NO TEXT ON THIS PAGE

SECTION 06100

MISCELLANEOUS ROUGH CARPENTRY

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, material, tools, equipment, and incidentals as shown, specified, and required to furnish and install all miscellaneous rough carpentry Work.
2. The Work also includes:
 - a. Providing openings in miscellaneous rough carpentry to accommodate the Work under this and other Sections and building into miscellaneous rough carpentry items such as sleeves, anchorages, inserts and other items to be embedded in or penetrating miscellaneous rough carpentry for which placement is not specifically provided under other Sections.
3. Extent of miscellaneous rough carpentry is shown or indicated.
4. Types of materials required include:
 - a. Miscellaneous blocking, furring strips, and other miscellaneous wood framing.
 - b. Lumber for temporary protection.
 - c. Lumber for temporary support.
 - d. Pressure treatment of lumber specified in this Section.
 - e. Miscellaneous accessories.
 - f. Air and water infiltration barrier system.
 - g. Vapor barrier system.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before miscellaneous rough carpentry Work.
2. Notify other contractors in advance of installing miscellaneous rough carpentry to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before miscellaneous rough carpentry Work.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ALSC PS 20, American Softwood Lumber Standard.
2. ASME B18.2.1 Square and Hex Bolts and Screws, Inch Series.
3. ASME B18.6.1 Wood Screws, Inch Series.
4. ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
5. ASTM D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
6. ASTM D5516, Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.
7. ASTM D5664, Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
8. ASTM D6305, Practice for Calculating Bending Strength Design Adjustment Factors for Fire-Retardant-Treated Plywood Roof Sheathing.
9. ASTM D6841, Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber.
10. ASTM F1667, Specification for Driven Fasteners: Nails, Spikes, and Staples.
11. AWPA M4, Care of Preservative Treated Wood Products.
12. AWPA P5, Waterborne Preservatives.
13. AWPA P17, Fire Retardant Formulations.
14. AWPA T1, Use Category System: Processing and Treatment Standard.
15. AWPA U1, Use Category System: User Specification for Treated Wood.
16. APA E445S, Performance Standards and Policies for Structural-Use Panels (APA PRP-108).
17. NIST PS-1, Construction and Industrial Plywood.
18. National Lumber Grade Authority (NLGA), Standard Grading Rules for Canadian Lumber.
19. Northeastern Lumber Manufacturers Association (NELMA), Standard Grading Rules for Northeastern Lumber.
20. Southern Pine Inspection Bureau (SPIB), Standard Grading Rules for Southern Pine Lumber.
21. West Coast Lumber Inspection Bureau (WCLIB), Standard Grading Rules.
22. Western Wood Products Association (WWPA), Western Lumber Grading Rules.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and the building code referred to in Section 01410, Regulatory Requirements for size, spacing, and attachment of wood members, unless more stringent requirements are shown or specified in the Contract Documents.
- B. Certifications:
 - 1. Pressure Treatment: For each type of pressure treatment specified, submit certification by wood treating plant stating chemicals and process used, and certifying conformance with applicable standards referenced in the Contract Documents.
 - a. For water borne preservatives, include statement that moisture content of treated materials was reduced to maximum of 19 percent prior to shipment to the Site.
 - 2. Certificates of Grade: Where appearance of wood is important and grade marks will deface the Work, in lieu of grade markings on wood, submit certificates attesting that materials comply with grade requirements specified.

1.04 SUBMITTALS

- A. Action Submittals; Submit the following:
 - 1. Shop Drawings:
 - a. List of species and grade of lumber proposed for each use.
 - b. Fastener schedule with location, size, material and type of each fastener to be used in the Work.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Lumber treater's certification of compliance, in accordance with Paragraph 1.03.B.1 of this Section.
 - b. Certificates of grade in accordance with Paragraph 1.03.B.2 of this Section.
 - 2. Manufacturer's Instructions:
 - a. Chemical treatment manufacturer's instructions for proper use of each type of treated material.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete or masonry in ample time to prevent delaying the Work.
 - 2. Handle treated materials in accordance with AWP A M4.

B. Storage and Protection:

1. Keep materials dry during delivery and storage.
2. Keep materials off ground using pallets, platforms, or other appropriate supports. Protect materials from corrosion and deterioration. Stack lumber and provide air circulation within stacks.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Lumber, General:

1. Factory-mark each piece of lumber with type, grade, mill and grading agency. Surfaces that will be exposed to view shall not have grade marks or other types of identifying marks.
2. Nominal sizes are shown or indicated, unless otherwise shown or indicated in the Contract Documents. Provide actual sizes as required by ALSC PS 20 for moisture content specified for each use.
 - a. Provide dressed lumber, surfaced four sides (S4S), unless otherwise shown or specified.
 - b. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing.
3. Provide the following grade and species:
 - a. Construction Grade, for material up to and including four-inch wide.
 - b. No. 2 or better for material greater than four-inch wide up to and including 12-inch wide.
 - c. Douglas Fir, WWPA.
4. Lumber for Protection and Temporary Support: Size and grades to conform to Laws and Regulations, including OSHA.

B. Plywood for Diaphragms: Provide the following:

1. NIST PS-1 rated sheathing, exterior exposure, Grade C-C, with minimum thickness shown on the Drawings, and span rating not less than 24/0.
 - a. Mark each sheet to identify plywood by species group or span rating, exposure durability classification, grade, and compliance with NIST PS-1). Surfaces that will be exposed to view shall not bear grade marks or other identifying marks.

C. Oriented Strand Board for Roof Sheathing: Provide the following:

1. APA E445S, sheathing grade with durability equivalent to Exposure 1 and span rating not less than 24/16.
 - a. Mark each panel with a mark that identifies end use, span rating, and exposure durability classification.

D. Vapor Barrier:

1. Provide reinforced rubber, modified high density polyethylene vapor barrier with perm rating of 0.045 maximum. Provide maximum widths to minimize field seaming.
2. Provide adhesive, tapes and flashings as recommended by vapor barrier manufacturer, of type that maintains perm rating of entire vapor barrier installation.
3. Products and Manufacturers: Provide one of the following:
 - a. Rufco SS-300 Vapor Retarder and Adhesives by Raven Industries, Inc.
 - b. Or approved equal.

E. Fasteners and Anchorages:

1. Fasteners exposed to the weather as well as fasteners embedded in, or in contact with, preservative treated wood shall be hot-dip galvanized.
2. Common wire nails shall conform to ASTM F1667.
3. Wood screws shall conform to ASME B18.6.1.
4. Anchorage devices shall conform to Section 05051, Anchor Systems.
5. Use joist hangers, framing anchors and clips where shown or specified.
 - a. Joist hangers shall be steel, zinc coated, sized to fit the supporting member, of sufficient strength to develop full strength of the supported member in accordance with applicable building code, and furnished complete with special nails required by joist hanger manufacturer.
 - b. Framing anchors shall be hot-dip galvanized steel conforming to ASTM A653/A653M, Z275 G90. Steel shall not be lighter than 18-gage. Use special nails furnished by manufacturer for nailing.
 - c. Clips shall consist of hot-dip galvanized conforming to ASTM A653/A653M, Z275 G90 steel angles, minimum 3/16-inch thick.

2.02 WOOD TREATMENT

A. Preservative Treatment: Where lumber is specified in this Section as treated, comply with AWPA P5, "Alkaline Copper Quat Mixture". Mark each treated item to comply with AWPA quality mark requirements.

1. Pressure-treat above ground items with water-borne preservatives in accordance with AWPA U1 and AWPA T1. After treatment, kiln-dry to maximum moisture content of 19 percent. Treat materials indicated on the Drawings and the following:
 - a. Wood nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - b. Wood, plates, blocking, furring, stripping, and similar concealed members and wood in contact with masonry, concrete, or steel.
 - c. Soffit and rain drainage framing.

2. Complete the fabrication of treated items prior to treatment, wherever possible. If wood is cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of wood after drying and discard damaged or defective pieces.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine substrates and supporting structure and conditions under which miscellaneous rough carpentry Work will be installed and notify ENGINEER in writing of conditions detrimental to proper completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Coordination: Fit miscellaneous rough carpentry Work to other Work and work under other contracts, as applicable, and scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other construction.
- B. General:
 1. Discard units of material with defects that might impair quality of the Work, and units too small to fabricate the Work with minimum joints or optimum joint arrangement.
 2. Set miscellaneous rough carpentry Work accurately to required levels and lines, with members plumb and true, accurately cut and fitted.
 3. Securely attach miscellaneous rough carpentry Work to substrates by anchoring and fastening as shown and indicated in the Contract Documents. Countersink nail heads on exposed miscellaneous rough carpentry Work and fill holes. Make tight connections between members.
 4. Install fasteners without splitting of wood, pre-drill as required and for masonry anchors fastened to wood stud wall framing.
- C. Wood Grounds, Nailers, and Blocking:
 1. Provide where shown or indicated, and where required for attachment of other construction. Form to shapes as shown or indicated and cut as required for true line and level of Work to be attached. Coordinate location with other work involved.
 2. Attach substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown or indicated.
 3. Provide permanent grounds of dressed, preservative-treated, key-bevelled lumber not less than 1.5-inch wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.
- D. Plywood, General:
 1. Install in accordance with the Contract Documents and requirements of authorities having jurisdiction.

2. Allow for installed clearances between individual plywood panels as specified by plywood manufacturer. Provide 1/4-inch space at panel edge joints and 1/8-inch space at panel end joints, unless otherwise recommended by manufacturer.
3. Install plywood with long dimension across supports.
4. Install roof sheathing using 8d helical or annular nails spaced six inches at panel edges and 12 inches at intermediate framing.
5. Provide panel edge clips at unsupported edges of roof sheathing.

E. Plywood, Diaphragm:

1. Diaphragms shall be blocked or unblocked, as shown or indicated on the Drawings. Comply with nailing schedule on the Drawings.
2. Provide continuous lumber blocking at unsupported edges of blocked diaphragms. Do not use panel edge clips in blocked diaphragms.

F. Vapor Barrier:

1. Install vapor barrier over entire interior room-side surfaces of exterior gypsum board perimeter walls, and over entire interior room-side surface plane of bottom of ceiling joists.
2. Install in accordance with manufacturer's written recommendations and using all taped joints and all taped fastener location to maintain perm rating of entire installed system in accordance with the Contract Documents.

END OF SECTION 06100

NO TEXT ON THIS PAGE

SECTION 07650

FLEXIBLE MASONRY FLASHING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all flexible masonry flashing Work. The Work also includes:
 - a. Providing openings in the flexible masonry flashing to accommodate the Work under other Sections and building into the Work all items such as sleeves, anchor bolts, inserts and other items to be embedded in flexible masonry flashing for which placement is not specifically provided under other Sections.
2. Extent of flexible masonry flashing is shown on the Drawings.
3. Types of flexible flashing Work required include, but are not necessarily limited to, the following:
 - a. Flexible glass reinforced asphalt/copper laminate flashing in exterior unit masonry wall construction.
 - b. Miscellaneous adhesives and sealants.

B. Coordination:

1. Review requirements and procedures under other Sections and coordinate with Work related to this Section.
2. Work advanced without built-in flashings shall be removed and rebuilt as required by ENGINEER at no additional expense to OWNER, even if discovered only after walls and other materials are in-place.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 04005, Masonry.
3. Section 07920, Joint Sealants.

1.02 QUALITY ASSURANCE

- A. Source Quality Control: Obtain all flexible flashing materials from only one manufacturer.
- B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 1. ASTM D 412, Test for Rubber Properties in Tension.

2. ASTM D 570, Water Absorption of Plastics.
3. ASTM D 746, Test for Brittleness Temperature of Plastics and Elastomers by Impact.
4. ASTM D 1499, Recommended Practice for Operating Light and Water - Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics.
5. ASTM D 2240, Test for Rubber Property-Durometer Hardness.

1.03 SUBMITTALS

- A. Samples: Submit for approval 12-inch by 12-inch sample of specified material.
- B. Shop Drawings: Submit for approval copies of specifications, installation instructions and general recommendations from the flashing materials manufacturer, for the types of flashing products required. Include manufacturer's certification or other data substantiating that the materials comply with the requirements. Include documentation of improved performance claimed for products or methods which exceed the requirements.

1.04 PRODUCTS DELIVERY, STORAGE AND HANDLING

- A. Delivery of Products:
 1. Deliver products and materials in original unopened packages, containers, or bundles with manufacturer's label intact and legible.
 2. Remove items delivered in broken, damaged, rusted, or unlabeled condition from project site immediately.

1.05 JOB CONDITIONS

- A. Coordinate flexible masonry flashings with other Work to ensure secure anchorage and watertight seals, and to minimize exposure to puncture or other damage from the work of other trades.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Asphalt Fabric and Copper Laminate Flashing:
 1. Provide two layers of asphalt impregnated glass laminated to copper core, formed into uniform flexible sheets not less than 7 ounces per square foot.
 2. Provide custom field-fabricated and preformed inside and outside corner boots.
 3. Product and Manufacturer: Provide one of the following:
 - a. Copper Fabric Flashing by Advanced Building Product, Incorporated.
 - b. Or approved equal.
- B. Miscellaneous Materials:
 1. Adhesives: Provide the types of adhesive compounds and tapes recommended by the flashing sheet manufacturer for bonding of substrate, if required, for waterproof sealing of

seams in the flashing, and for waterproof sealing of joints between flashing, membrane, adjoining surfaces, projections through the flashing, and for securing into cast-in-place reglets.

2. Sealants: Refer to Section 07920, Joint Sealants.
3. Provide Type 316 stainless steel drip edge 1-1/2" wide at all locations where exposed flashing is not noted.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine the substrate and the conditions under which the flexible flashing Work is to be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the flexible flashing Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER. Commencement of the Work shall imply agreement by CONTRACTOR that the requirements of this Section can be fulfilled.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. It is the intention of this Section to provide a completely watertight wall flashing system. CONTRACTOR shall supply this system.
- B. Comply with manufacturer's instructions for handling and installation of the flexible masonry flashing materials, except where more stringent requirements are shown or specified.
- C. Build flexible masonry flashing Work into unit masonry construction as unit masonry construction Work progresses. Work advanced without built-in flashings shall be removed and rebuilt as required by ENGINEER.
- D. Seal all joints between flashing membrane watertight.
- E. Coordinate the installation of flashing materials and associated Work so as to provide a complete system complying with the combined recommendations of manufacturers and installers involved in the Work.
- F. Refer to Section 04005, Masonry, for installation of flexible through wall flashing with masonry.
- G. Use only installation techniques approved by the flexible masonry flashing manufacturer.

3.03 FIELD TESTS

- A. Field test all flexible masonry flashing Work for water tightness upon completion.

3.04 ADJUSTMENT

- A. Repair flexible flashing at leaks.
- B. Unit masonry walls which leak due to improper flexible flashing installation shall be corrected at no further expense to OWNER.

END OF SECTION 07650

NO TEXT ON THIS PAGE

SECTION 07920
JOINT SEALANTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
2. Extent of each type of calking and sealant is shown or indicated and includes the following:
 - a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
 - b. Joints specified to be recalked.

B. Coordination:

1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 03005, Concrete.
3. Section 04005, Masonry.
4. Section 08115, Hollow Metal Doors and Frames.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
5. ASTM C920, Specification for Elastomeric Joint Sealants.

6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
8. ASTM C1193, Guide for Use of Joint Sealants.
9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
10. BAAQMD Regulation 8, Rule 51.
11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
14. SCAQMD Rule 1168.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Installer:
 - a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
2. Testing Laboratory:
 - a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.

B. Component Supply and Compatibility:

1. Obtain materials only from manufacturers who will, if required:
 - a. Furnish at the Site services of a qualified technical representative to advise installer of proper procedures and precautions for using materials.
 - b. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.

- C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.

1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
2. Test other joint sealants for compliance using specified post-construction field adhesion test.

1.04 SUBMITTALS

- A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
2. Product Data:
 - a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
 - b. Product test reports.
3. Samples:
 - a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
 - b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is responsibility of CONTRACTOR.

- B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
 - b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
 - c. Certify that applicator is approved by manufacturer.
2. Field Quality Control Submittals:
 - a. Results of tests on job mock-ups.
 - b. Pre-construction and post-construction field test reports.
 - c. Compatibility and adhesion test reports.

- d. Contractor's Field Test Report Logs:
 - 1) Indicate time present at the Site.
 - 2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.

C. Closeout Submittals: Submit the following:

- 1. Operation and Maintenance Data:
 - a. Recommended inspection intervals.
 - b. Instructions for repairing and replacing failed sealant joints.
- 2. Warranty: Submit written warranties as specified in this Section.

1.05 DELIVERY, STORAGE AND HANDLING

A. Comply with the following:

- 1. Delivery of Products:
 - a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
 - b. Include the following information on label:
 - 1) Name of material and Supplier.
 - 2) Formula or Specification Section number, lot number, color and date of manufacture.
 - 3) Mixing instructions, shelf life, and curing time, when applicable.
- 2. Storage of Products:
 - a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
 - b. Do not use materials that are outdated as indicated by shelf life.
 - c. Store sealant tape in manner that will not deform tape.
 - d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
 - e. When high temperatures prevail, store mixed sealants in a cool place.
- 3. Handling:
 - a. Do not open containers or mix components until necessary preparatory Work and priming are complete.

1.06 JOB CONDITIONS

A. Environmental Conditions:

1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.
7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where OWNER's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.07 WARRANTY

- A. Provide written warranty, signed by manufacturer and CONTRACTOR, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
1. Provide manufacturer warranty for period of one year from date of Beneficial Use of joint sealants Work.
 2. Provide installer warranty for period of two years from date of Beneficial Use of joint sealants Work.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

- A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. VOC Performance Criteria:
1. VOC content of sealants used shall comply with current VOC content limits of SCAQMD Rule 1168. Sealants used as fillers shall comply with or exceed requirements of BAAQMD Regulation 8, Rule 51.

- a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
- C. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.02 MATERIALS

A. Exterior and Interior Vertical Joints; Non-submerged:

1. Two-component Polyurethane Sealant:

- a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.
- b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) VOC Content: 100 g/L, maximum.

B. Exterior and Interior Horizontal Joints; Non-submerged:

1. Two-component Polyurethane Sealant:

- a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c SL by Sika Corporation.
 - 2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or approved equal.

- b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
 - 1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
 - 2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
 - 3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
 - 4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) VOC Content: 165 g/L, maximum.

C. Miscellaneous Materials:

- 1. Joint Cleaner: As recommended by calking and sealant manufacturer.
- 2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
- 3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
- 4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
- 5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.
- B. Laboratory Pre-construction Compatibility and Adhesion Testing: Submit to joint sealant manufacturers for testing indicated below samples of materials that will contact or affect joint sealants.

1. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit at least eight pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For products that fail tests, obtain joint-sealant manufacturer's written instructions for corrective measures including using specially formulated primers.
5. Immersion Testing: ASTM C1247 for potable water and wastewater.
6. Testing will not be required if joint sealant manufacturers submit joint preparation data based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted and mock-up field testing is acceptable.

3.02 PREPARATION

- A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.
- B. Joint Surface Preparation:
 1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
 2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
 3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
 4. Concrete Joint Preparation: Refer to Section 03005, Concrete.
- C. Mixing:
 1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
 2. Thoroughly mix components before use.
 3. Add entire contents of activator can to base container. Do not mix partial units.
 4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.03 INSTALLATION

- A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.
- B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to ENGINEER.
- C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.
- D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.
- E. Confirm that compressible filler is installed before installing sealants. Refer to Section 04005, Masonry, for locations.
- F. Do not install sealants without backer rods and bond breaker tape.
- G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.
- H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
 - 1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 - 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
- J. Remove excess and spillage of compounds promptly as the Work progresses.
- K. Cure calking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.04 EXISTING JOINTS

- A. Mechanically remove existing sealant and backer rod.
- B. Clean joint surfaces of residual sealant and other contaminants capable of affecting sealant bond to joint surface.

- C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.01.B of this Section.
- D. Allow joint surfaces to dry before installing new sealants.

3.05 FIELD QUALITY CONTROL

- A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
 - c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
 - d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.
 - e. Inspect tested joints and report on whether:
 - 1) Sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 2) Sealants filled the joint cavities and are free of voids.
 - 3) Sealant dimensions and configurations comply with specified requirements.
 - f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
 - h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
 - i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or

shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

B. Water Leak Testing: Field test for water leaks as follows:

1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of ENGINEER, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
3. Where nature of observed leaks indicates potential of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Beneficial Use.

3.06 ADJUSTING AND CLEANING

- A. Where leaks and lack of adhesion are evident, replace sealant.
- B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.
- C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.07 PROTECTION

- A. During and after curing period, protect joint sealants 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 Beneficial Use. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

END OF SECTION 07920

NO TEXT ON THIS PAGE

SECTION 08115

HOLLOW METAL DOORS AND FRAMES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hollow metal doors and frames.
2. Extent of hollow metal doors and frames is shown.
3. Types of products required include the following:
 - a. Seamless, galvanized steel, paper honeycomb core, internally reinforced, flush doors.
 - b. Miscellaneous supports; special, supplemental and standard finish hardware reinforcements and preparation items; fasteners and accessories; all for high frequency, high-endurance use.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the hollow metal doors and frames Work.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 04005, Masonry.
3. Section 07920, Joint Sealants.
4. Section 08710, Door Hardware.
5. Section 09900, Painting.

1.02 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
 - a. ANSI in association with Steel Door Institute, ANSI/SDI 100, Steel Doors and Frames.
 - b. ANSI in association with Door and Hardware Institute, ANSI/A115.1-A115.17/DHI, Specifications for Steel Door and Frame Preparation for Hardware.
 - c. ANSI A224.1, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

- d. ANSI A250.3, Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.
 - e. ANSI A250.4, Test Procedures and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.
 - f. ANSI A250.5, Accelerated Physical Endurance Test Procedure for Steel Doors, Frames, and Frame Anchors.
 - g. ANSI/NFPA 252, Fire Tests of Door Assemblies.
- 2. American Society for Testing and Materials, (ASTM).
 - a. ASTM A 153/A 153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. ASTM A 366, Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
 - c. ASTM A 653/A 653M, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by The Hot-Dip Process.
 - d. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
 - e. ASTM E 1408, Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.
- 3. Door and Hardware Institute, (DHI).
 - a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
- 4. National Fire Protection Association, (NFPA).
 - a. NFPA 80, Fire Doors and Fire Windows.
- 5. Steel Door Institute, (SDI/Door).
 - a. SDI/Door 105, Erection Instructions for Steel Frames.
 - b. SDI/Door 106, Standard Door Type Nomenclature.
 - c. SDI/Door 112, Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames.
 - d. SDI/Door 117, Manufacturing Tolerances Standard Steel Doors and Frames.
 - e. SDI/Door 122, Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
 - f. SDI/Door 128, Guidelines for Acoustical Performance of Standard Steel Doors and Frames.

6. The Society for Protective Coatings, (SSPC).
 - a. SSPC Paint 2, Cold Phosphate Surface Treatment.
 - b. SSPC Paint 27, Basic Zinc Chromate-Vinyl Butyral Wash Primer.
7. Underwriters' Laboratories Inc., (UL).
 - a. UL 10B, Fire Tests of Door Assemblies.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have a minimum of five years' experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
2. Provide hollow metal doors, frames, and accessories manufactured by a single firm specializing in the production of this type of Work and complying with specified standards of ANSI, NFPA, SDI and UL.
3. Provide hollow metal doors and frames from a manufacturer who is a member of SDI.

B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hollow metal doors and frames manufacturer.
2. The hollow metal doors and frames equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the hollow metal doors and frames manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Fabrication and installation drawings of hollow metal doors and frames. Include details of each frame type, elevations of each door type, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints, connections and every composite member. Show all door and frame reinforcements, including welds, plate lengths, locations and gauges, identified for each component of finish hardware specified in Section 08710, Door Hardware.
 - b. Provide a schedule of doors and frames using same reference numbers for details and openings as those shown.

2. Samples:

- a. Pressed metal corner section of frame, 12-inches by 12-inches minimum, showing all special, supplemental and standard reinforcements, attachments, supports and anchors specified. Provide corner sample for each type of frame specified.
- b. Engineer reserves the right to require samples showing fabrication techniques and workmanships of all component parts, and the detailing and fabrication of accessories and auxiliary items for all door and frame Work, before fabrication of the Work proceeds.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
2. Deliver hollow metal doors and frames cartoned or crated to provide protection during transit and job storage.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store doors and frames at the Site under cover.
3. Place units up off floors in a manner that will prevent rust and damage.
4. Avoid the use of non-vented plastic or canvas shelters, which could create a humidity chamber. If cardboard wrapper on the door becomes wet, remove the carton immediately.
5. Provide a 1/4-inch space between stacked doors to promote air circulation.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Design Criteria:

1. Door Classification: Provide hollow metal doors of Grades and Models in accordance with ANSI/SDI 100, and ANSI A250.5 as follows:
 - a. Grade II, Heavy-Duty, 1-3/4-inches thick (Level B); Model 2A, seamless design.

B. Details of Construction:

1. Provide doors of two outer stretcher-leveled sheets, 14-gauge minimum. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or edges, except around glazed or louvered panel inserts. No fillers shall be used. Provide weep hole openings in the bottom of exterior doors to permit the escape of entrapped moisture.
2. Reinforce inside of doors with honeycomb core completely filling the inside of the door and laminated to the inside of both face panels with an adhesive. The honeycomb material shall have a crushing strength not less than 6,000 pounds per square foot and the lamination shall withstand not less than 1,100 pounds per square foot in shear.

C. Frame Construction:

1. Form frames of cold-rolled sheet material, 14-gauge minimum. Provide seamless frames for all Work, unless specifically specified and shown as permitting exposed fasteners.
2. Provide hollow metal frames for doors, transoms, side-lights, borrowed lights, and other openings of size and profile as shown or specified.

2.02 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:

1. Series CH with DURA-WELD seams with Series F 14 Frames and DW 14 Frames by Pioneer Industries, Incorporated.
2. Or equal.

2.03 MATERIALS

- A. Door Faces and Frames: Zinc-coated, cold-rolled carbon steel sheets of commercial quality, complying with ASTM A 366, and ASTM A 653/A 653M, G 60 zinc coating, mill-phosphatized.
- B. Honeycomb Core: Phenolic resin-impregnated, nominal 1-inch hexagonal cell size, one piece, Kraft fiber core board, with 42 psi minimum crushing strength.
- C. Supports and Anchors: Formed sheet metal, hot-dip galvanized after fabrication complying with ASTM A 153/A 153M, Class B, and in compliance with requirements of ANSI A250.5. Provide supports and anchors as follows:
 1. Jamb Anchors: 16-gauge minimum, and of the following types:
 - a. Masonry Construction: Adjustable, corrugated or perforated, T-shaped to suit frame size with leg not less than 2-inches wide by 10-inches long.
 2. Floor and Head Anchors: 14-gauge minimum, and of the following types:
 - a. Monolithic Concrete Slabs: Clip-type, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 - b. Separate Topping Concrete Slabs: Adjustable-type with extension clips, allowing not less than 2-inches height adjustment. Terminate bottom of frames at finish floor surface.
- D. Inserts, Bolts and Fasteners: Sheet metal hot-dip galvanized complying with ASTM A 153/A 153M, Class C or D as applicable.

E. Miscellaneous Accessories:

1. Head Strut Supports: 3/8-inch by 2-inch hot-dipped galvanized steel.
2. Structural Reinforcing Members: Provide structural reinforcing members as part of frame assembly, where shown at mullions, transoms, or other locations that are to be built into frame.
3. Head Reinforcing: For frames over 4 feet-0 inch wide, in masonry openings, provide continuous steel channel or angle stiffener, not less than 12-gauge for full width of opening, welded to back of frame at head.
4. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
5. Plaster Guards: 26-gauge minimum galvanized steel.
6. Louvers, Stops and Moldings: 16-gauge minimum, cold-rolled, hot-dipped galvanized, formed sheet metal.
7. Insect Screen: 14 by 18 bronze wire mesh in a rigid, formed metal frame.

2.04 FABRICATION

A. General:

1. Fabricate hollow metal units to be rigid, neat in appearance and free for defects, warp or buckle. Accurately form metal to required sizes and profiles.
2. Wherever practicable, fit and assemble units in the manufacturer's plant. Clearly identify Work that cannot be permanently factory-assembled before shipment, to assure proper assembly at the Site. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Filler to conceal manufacturing defects shall not be acceptable.
3. Exposed Fasteners: Unless otherwise shown or specified, do not use exposed fasteners in the Work. Where exposed fasteners are shown or specified, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

B. Doors:

1. Fabricate all hollow metal doors and panels in compliance with ANSI A250.5.
2. Fabricate all doors with flush top and bottom closing channel, without exposed fasteners. Reinforce tops and bottoms of doors with inverted, flush-mounted, minimum 20-gauge, horizontal steel channels fastened to internal reinforcement channel and with 20-gauge closing plate spot-welded to closure channel. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels and plates.
3. Hollow Metal Panels:
 - a. Fabricate hollow metal panels of the same materials, construction, and finish as specified for hollow metal doors.
 - b. Provide astragal integral with top of door where shown.
4. Edge profiles shall be provided on both stiles of doors beveled 1/8-inch in 2-inches.

C. Frame Construction:

1. Fabricate all hollow metal frames in compliance with ANSI A250.5 and as specified.
2. Fabricate frames with reinforced, mitered corners that are continuously arc-welded for the full depth and width of the frame, with bottom spreader bar; except provide drywall frames as specified.
3. Grind all exposed welds flush and smooth.
4. Knock-down-type frames shall be used for drywall construction only and shall provide the following additional features:
 - a. Specifically designed for drywall construction.
 - b. Frames shall be knocked down, designed to be securely installed in the rough opening after the wallboard is applied.
 - c. Jamb and head connection shall be a neat, flush, miter with head securely locked to top of jamb.
 - d. Mitered corners shall be reinforced with a concealed corner cup to provide a firm interlock of jamb to head.
 - e. Provide two anchors at head of frames exceeding 3 foot-6 inches wide.
 - f. Provide vertical steel head support struts extending from top of frame at each jamb to supporting construction above. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
5. Head Reinforcing: Where installed in masonry, leave vertical mullions in frames open at the top so they can be filled with grout.
6. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
7. Head Anchors: Provide two anchors at head of frames exceeding 3 foot-6 inches wide for frames mounted in drywall partitions.
8. Head Strut Supports: Provide vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
9. Rubber Door Silencers: Drill stop to receive three silencers on single-door frames and four silencers on double-door frames. Install plastic plugs to keep holes clear during construction.
10. Plaster Guards: Provide manufacturer's standard plaster guards or dust cover boxes.

D. Finish Hardware Preparation:

1. General:
 - a. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with approved Finish Hardware Schedule and templates provided by finish hardware supplier and as

specified. Comply with applicable requirements of ANSI/DHI A115.1 to A115.17 and ANSI A250.4. Refer to Section 08710, Door Hardware.

- b. Obtain approved hardware schedule, hardware templates, and samples of finish hardware where necessary to ensure correct detailing and fabrication of the hollow metal doors and frames, from finish hardware supplier.

2. Doors:

- a. Preparation includes sinkages and cut-outs for mortised and concealed finish hardware and reinforcements for both concealed and surface-applied finish hardware.
- b. Drill and tap mortise reinforcements at factory, using templates.
- c. Detail and fabricate reinforcements with concealed connections designed to develop full strength of reinforcements for high-frequency applications.
- d. Reinforce doors for required finish hardware, with minimum gauges of reinforcements provided as follows:
 - 1) Hinges: Steel plate 3/16-inches thick by 1-1/2-inches wide by 6-inches longer than hinge and secured by not less than six spot or projection welds with top hinge further reinforced with a high-frequency back-up reinforcement.
 - 2) Mortise Locksets and Dead Bolts: 12-gauge steel sheet, secured with not less than four spot or projection welds.
 - 3) Cylinder Locks: 12-gauge steel sheet, secured with not less than two spot or projection welds.
 - 4) Surface-Applied Closers and Overhead Stops: 3/16-inch steel plate, not less than 10-inches long, secured with not less than six spot or projection welds.
 - 5) Push Plates and Bars: 16-gauge steel sheet secured with not less than two spot or projection welds.
 - 6) Surface Panic Devices: 16-gauge sheet steel secured with not less than two spot or projection welds.

3. Frames:

- a. Reinforce frames for required finish hardware with minimum gauges as follows:
 - 1) Hinges and Pivots: Special full width of frame, 3/16-inch thick steel plate by 8-inches longer than hinge, secured to both rabbets by not less than twelve spot or projection welds.
 - 2) Strike Plate Clips: 10-gauge steel plate by 1-1/2-inches wide by 3-inches long with mortar guard boxout secured with not less than six spot or projection welds.
 - 3) Surface-Applied Closers: 3/16-inch steel plate, secured with not less than six spot or projection welds. Coordinate closer function and presence of overhead stops and weather-stripping, with location of reinforcement plate.

2.05 SHOP PAINTING

- A. Clean, treat and paint exposed surfaces of fabricated hollow metal units, including galvanized surfaces.
- B. Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before the application of the shop coat of paint.
- C. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC Paint 2), or basic zinc chromate-vinyl butyral solution (SSPC Paint 27).
- D. Refer to Section 09900, Painting, for field-applied primer and finish paint for exterior or interior exposed ferrous, non-ferrous, or galvanized surfaces.
- E. Apply shop-coat of prime paint within time limits recommended by pretreatment manufacturer. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 1.5-mils.
- F. Finish shall be rust inhibitive primer capable of passing a 500-hour salt spray and a 1,000-hour humidity test in accordance with ASTM B 117 as certified by an independent laboratory.

2.06 SOURCE QUALITY CONTROL

- A. After Shop Drawings approval, manufacturer shall not make any further detailing, fabrication or changes to approved methods of support and anchorage, nor shall doors and frames be brought to the Site, which do not conform, in all ways, to performance criteria specified.
- B. Prepare a written report on the testing of up to 1 hollow metal flush door and frame, selected at random by Engineer from those brought to the Site, for the purpose of verifying, by independent laboratory analysis, the provision of all features specified and indicated on approved Shop Drawings, at no additional cost to Owner. Any door and frame found failing to comply with specified features shall be cause for Engineer to require complete removal of all doors and frames from the Site, and the provision of new units complying with this Section, as confirmed by independent laboratory testing, at no additional cost to Owner.
- C. Allowable Tolerances: Provide door and frame manufacturing tolerances in compliance with SDI 117 and as follows:
 - 1. Nominal Clearance between Door and Frame Head and Jamb: 1/8-inch.
 - 2. Nominal Clearance between Meeting Edges of Pairs of Doors: 1/8-inch.
 - 3. Nominal Clearance at Bottom of Door: 3/4-inch.
 - 4. Nominal Clearance between Face of Door and Door Stop: 1/16-inch.
 - 5. Provide all Work plumb and true to adjoining surfaces with all miters and copes accurately formed.
 - 6. Provide completely water and vapor tight joints.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Contractor shall examine the substrate and conditions under which hollow metal doors and frames are to be installed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- B. Frames that are bowed, twisted or otherwise unacceptable shall be removed from the Site and replaced with properly constructed frames.

3.02 PREPARATION

- A. Drilling and tapping for surface-applied, finish hardware may be done at Site.
- B. Protective Coating: Protect inside, concealed, faces of door frames in plaster or masonry construction using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8-inches thick and allow to dry before installation.

3.03 INSTALLATION

- A. Install hollow metal units and accessories in accordance with approved Shop Drawings, SDI 105 and as shown and specified.
 - 1. Do not install doors and frames until all the Work, which could damage doors and frames, has been completed.
 - 2. Provide temporary doors until construction sequencing allows installation of permanent doors and frames.
 - 3. Do not proceed with the installation of permanent hollow metal doors until Contractor can provide finished Work complying with all requirements of these Specifications.
 - 4. Protect built-in frame Work with temporary wood protection.
- B. Placing Frames:
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Remove spreader bars only after frames have been properly set and secured.
 - 2. Make field splices in frames as detailed on approved Shop Drawings, welded and finished to match factory work.
- C. Setting Masonry Anchorage Devices:
 - 1. In masonry construction, building in of anchors and grouting of frames is included in Section 04005, Masonry.
 - 2. Set anchorage devices opposite each anchor location, in accordance with details on approved Shop Drawings and anchorage device manufacturer's instructions as follows:
 - a. Masonry Walls: Install at least three jamb anchors per jamb up to 7 feet-6 inches height; four anchors up to 8 feet-0 inch jamb height; one additional anchor for each 2 foot-0 inch or fraction thereof over 8 feet-0 inch height.

3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated on approved Shop Drawings.

D. Door Installation:

1. Fit hollow metal doors accurately in their respective frames, with the following clearances:
 - a. Jambs and Head: 3/32-inch.
 - b. Bottom: At threshold or carpet, 1/8-inch.
2. Finish hardware installation is specified under Section 08710, Door Hardware. Locate finish hardware as shown on approved Shop Drawings, in accordance with hardware templates provided by finish hardware manufacturers and in accordance with Door and Hardware Institute, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

3.04 ADJUSTMENT AND CLEANING

- A. Check and readjust operating finish hardware items in hollow metal door and frame Work just prior to final inspection. Leave Work in complete and proper operating conditions.
- B. Where problems of installation or damage are cause for rejection of hollow metal door and frame Work, consult SDI 122 and the recommendations of the hollow metal door and frame manufacturer, for suggestions concerning required adjustments in the Work. Submit recommendations to Engineer for approval. Replace and repair unacceptable Work, as directed by Engineer, so that there will be no doubt as to the acceptability of the Work at the time of beneficial use.
- C. Prime Coat Touch-Up: Immediately after installation, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- D. Protection: Protect installed hollow metal doors and frames against damage from other construction activities.

END OF SECTION 08115

NO TEXT ON THIS PAGE

SECTION 08710

DOOR HARDWARE

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install door hardware. Furnish door hardware for all doors in compliance with these Specifications herein.
2. Extent of door hardware is specified. Door hardware is defined to include all items known commercially as door hardware, except special types of unique and non-matching hardware specified in the same Section as the door and door frame.
3. Types of products required include the following:
 - a. Mortise hinges.
 - b. Panic exit devices.
 - c. Overhead, surface-mounted, door closers.
 - d. Heavy-duty, concealed, adjustable, overhead holders and stops.
 - e. Door pulls, push plates and protection armor plate.
 - f. Stripping and seals.
 - g. Thresholds.
 - h. Silencers.
 - i. Floor stops.
 - j. Miscellaneous items and accessories for a complete installation functioning in compliance with the requirements of governing authorities having jurisdiction at the Site.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the door hardware.
2. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 08115, Hollow Metal Doors and Frames.

1.02 REFERENCES

A. Standards referenced in this Section are listed below:

1. American National Standards Institute, (ANSI).
 - a. ANSI A117.1, Accessible and Usable Buildings and Facilities.
2. American National Standards Institute, (ANSI), in association with Builders Hardware Manufacturers' Association, (ANSI/BHMA).
 - a. ANSI/BHMA A156.1, Butts and Hinges.
 - b. ANSI/BHMA A156.3, Exit Devices.
 - c. ANSI/BHMA A156.4, Door Controls - Closers.
 - d. ANSI/BHMA A156.6, Architectural Door Trim.
 - e. ANSI/BHMA A156.7, Template Hinge Dimensions.
 - f. ANSI/BHMA A156.8, Door Controls - Overhead Stops and Holders.
 - g. ANSI/BHMA A156.13, Mortise Locks and Latches, Series 1000.
 - h. ANSI/BHMA A156.16, American National Standard for Auxiliary Hardware.
 - i. ANSI/BHMA A156.18, Hardware - Materials and Finishes.
 - j. ANSI/BHMA A156.21, Thresholds.
 - k. ANSI/BHMA A156.22, Door Gasketing and Edge Seal Systems.
3. ANSI, in association with Door and Hardware Institute, (ANSI/DHI).
 - a. ANSI/DHI A115.1, Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames.
4. ANSI, in association with National Fire Protection Association, (ANSI/NFPA).
 - a. ANSI/NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
5. ANSI, in association with Underwriters' Laboratories, Inc., (UL).
 - a. UL 10B, Fire Tests of Door Assemblies.
6. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).
7. Door and Hardware Institute, (DHI).
 - a. DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
 - b. DHI, Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

- c. DHI, Sequencing and Format for the Hardware Schedule.
- 8. Hollow Metal Manufacturers Association, Division of National Association of Architectural Metal Manufacturers, (HMMA).
 - a. HMMA 830, Hardware Preparation and Locations for Hollow Metal Doors and Frames.
- 9. National Fire Protection Association, (NFPA).
 - a. NFPA 80, Fire Doors and Fire Windows.
- 10. Steel Door Institute, (SDI).
 - a. SDI 109, Hardware for Standard Steel Doors and Frames.
 - b. SDI 118, Basic Fire Door Requirements.
- 11. Underwriters' Laboratories, Inc., (UL).
 - a. UL 305, Panic Hardware.
 - b. UL, Building Materials Directory.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

- 1. Provide door hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
- 2. Provide door hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer's Qualifications:

- 1. The door hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, (DHI), who has passed the DHI certification examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing door hardware schedules and Shop Drawings and be present at the Site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the door hardware Work, and shall prepare a written field report on status of completed door hardware installation as specified.
- 2. Submit name and qualifications of the installer to ENGINEER.

C. Codes: Comply with applicable requirements of codes.

D. Source Quality Control:

- 1. Obtain each type of door hardware item from only one manufacturer.
- 2. Provide door hardware schedule, for submission to, and for approval by, ENGINEER, prepared in compliance with DHI standards.
- 3. Comply with specified BHMA standards.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

- a. Copies of manufacturer's data for each item of door hardware. Include whatever information may be required to show compliance with specified requirements and include instructions for installation and for maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of door hardware. Provide ENGINEER with latest complete technical catalogue of all available door hardware manufactured by proposed manufacturers, even if manufacturer specified by ENGINEER is submitted by CONTRACTOR to perform the Work. Furnish templates to fabricators of other Work, which is to receive door hardware.

2. Shop Drawings:

- a. Copies of the Door Hardware Schedule in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
 - 1) Prepare and submit Door Hardware Schedule in compliance with HDI standards.
- b. Based on the door hardware requirements specified, organize the final Door Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work (such as hollow metal frames) which may be critical in the Project Schedule. Furnish final draft of schedule after Samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.
- c. Include a separate key schedule, showing clearly how OWNER'S final instructions on keying of locks have been fulfilled.
- d. Door Hardware Schedules are intended for coordination of the Work. Review and acceptance by ENGINEER does not relieve CONTRACTOR of responsibility to fulfill the requirements as shown and specified.

B. Informational Submittals: Submit the following:

1. Test and Evaluation Reports:

- a. Certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.

2. Qualifications Statements:

- a. Installer.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Documentation: Upon completion of the Work, furnish five copies of detailed maintenance manuals, including the following information:
 - a. Product name and manufacturer.

- b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
- c. Detailed procedure for routine maintenance and cleaning.
- d. Detailed procedures for repairs such as dents, scratches and staining.
- e. Parts identification manual and maintenance manuals for each piece of door hardware.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

- 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
- 2. Deliver all items of door hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
- 3. Pack each piece of door hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.

B. Storage and Protection:

- 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- 2. Provide secure storage area for door hardware items, secured by locks and accessible only to door hardware installer, ENGINEER and CONTRACTOR.
- 3. Store door hardware in manufacturers' original packages.

C. Acceptance at Site:

- 1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Items that arrive in a damaged condition shall be removed from the Site and not offered again for acceptance. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Description:

- 1. Where the door, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving door hardware is such as to prevent, or make unsuitable, the types of door hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intension and requirements of governing authorities having jurisdiction at the Site. Clearly identify and highlight to ENGINEER all such required modifications on Shop Drawings submitted for approval.

2. If door hardware for any location is not specified, provide door hardware equal in design and quality to adjacent door hardware specified for comparable openings at no additional cost to OWNER.
3. Furnish door hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.

2.02 DETAILS OF CONSTRUCTION

A. General:

1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of door hardware for proper installation and operation of the door swing as shown.
2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities having jurisdiction at the Site.
3. Base Metals: Produce door hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
4. Fasteners: Manufacture door hardware to conform to published templates, generally prepared for machine screw installation. Do not provide door hardware, which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
5. Furnish screws for installation, with each door hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of door hardware, base material or fastener.
7. Provide concealed fasteners for door hardware units, which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.
8. Tools for Maintenance: Furnish two complete sets of specialized tools as required for OWNER'S continued adjustment, maintenance, removal and replacement of door hardware.

B. Mortise Hinges:

1. Templates and Screws: Provide only template-produced units.
2. Base Metal: Except as otherwise specified, fabricate hinges from stainless steel US32D and finish to match the latch and lock set.
3. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
 - a. Exterior Doors, 7-feet 2-inches Long.
4. Types of Hinges: Provide stainless steel barrel type continuous hinge, inner leaf beveled, square cornered.
5. Conform to ANSI/BHMA A156.26-1996, Grade 1.
6. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
7. Products and Manufacturers: Provide one of the following:
 - a. 651 by Stanley Commercial Hardware, Division of The Stanley Works.

C. Panic Exit Devices:

1. Exit Doors: Where required by governing authorities having jurisdiction at the Site, provide panic exit devices, of the type required, including UL labels.
2. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
3. Provide surface mounted vertical rod type exit device and mortise type exit devices as specified.
4. Provide the following features and materials:
 - a. Latch Bolt: Deadlocking anti-friction top and bottom bolt, 5/8" throw.
 - b. Case: Wrought steel, zinc dichromatized.
 - c. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
 - d. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
5. Thumbpiece.
6. Finish: US 26D Satin Chrome.
7. ANSI/BHMA: A156.3, 2008, Grade 1.

8. Products and Manufacturers: Provide one of the following:

- a. 9927 Series Fire Surface Mounted Vertical Rod Touch Bar Exit Device; with 06 Lever by Von Duprin, Incorporated, Division of Allegion.

D. Keying System:

1. Existing System: Grandmaster key or great-grandmaster keys the locks to OWNER'S existing system, with a new master key for the Project.
2. Review the keying system with OWNER'S and provide the type required (master, grandmaster or great grandmaster), either new or integrated with OWNER'S existing system.
3. Furnish all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these before beneficial use. Construction control keys and cores shall not be part of OWNER'S permanent keying system. Permanent cores and keys shall be furnished to OWNER prior to beneficial use.
4. Comply with the OWNER'S instructions for master keying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
5. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes shall not include the actual key cuts. Permanent keys shall also be stamped "DO NOT DUPLICATE".
6. Key Material: Nickel silver.
7. Key Quantity: Furnish three keys for each lock and five keys for each master and grandmaster system. Provide one extra key blank for each lock.
8. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, three-way visible card index, temporary markers, permanent markers and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project. Provide a hinged-panel type cabinet, for wall mounting.

E. Overhead, Surface-Mounted, Door Closers:

1. Provide all doors, unless specially shown or specified as being provided with floor-mounted or concealed overhead closers, with surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified as required.

6. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
7. Provide corner bracket mounting on exterior doors. Select all arms to clear weather-stripping, and overhead door holders.
8. Provide Cush-N-Stop to allow door to swing 100 degrees where it will eliminate floor-mounted stops.
9. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
10. Provide individual regulating valves for closing and latching speeds, and separate adjustable back check valve.
11. Provide delayed closing action feature on all door closers. Position valve at top of closure.
12. Provide the following materials and features:
 - a. Square Metal Cover: Satin stainless steel.
 - b. Case: Cast-iron.
 - c. Arms: Regular double lever.
 - d. Other Parts: Aluminum.
 - e. Thirty-year warranty.
 - f. Provide manufacturer's optional corrosion protection.
13. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
14. Highly Corrosive Atmospheres: Provide all closers with specified manufacturer's optional corrosion protection.
15. ANSI/BHMA: A156.4, C02011, in compliance with PT 1 and PT 4.
16. Products and Manufacturers: Provide one of the following:
 - a. LCN 4041XP by Allegion

F. Heavy-Duty, Concealed Overhead Holders and Stops:

1. Provide heavy-duty, concealed overhead holders and stops on all exterior and all interior doors, unless otherwise specified to receive an extra heavy-duty overhead holder and stop in List of Door Hardware Items at end of Part 3. Comply with UL and NFPA requirements for hold-open feature.
2. Provide the following features and materials:
 - a. Shock Absorber Spring: Heavy tempered steel.
 - b. Channel: Heavy-gauge brass.
 - c. All other Parts: Stainless steel.
 - d. Adjustment: Degree of hold-open and stop shall be adjustable after installation.

3. Finish: US 32D satin.
4. Coordinate placement of concealed overhead holder and stop with overhead closers.
5. ANSI/BHMA: A156.8, C51511.
6. Products and Manufacturers: Provide one of the following:
 - a. Heavy-Duty 100H (ADJ) Series Concealed Holders and Stops by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
 - b. Or approved equal.

G. Protection Armor:

1. Protection Armor:
 - a. Provide one armor plate per leaf of each door scheduled to receive armor-plate protection.
 - b. Provide 16-gauge stainless steel with No. 4 finish 2 foot-0 inches high by 12-inches less in width than width of door.
 - c. ANSI/BHMA: A156.6, J101; B3E.
 - d. Products and Manufacturers: Provide one of the following:
 - 1) 193S Beveled Stainless Steel Armor Plate by Hager Hinge Company.
 - 2) Or approved equal.

H. Stripping and Seals:

1. Provide perimeter weather stripping at all exterior doors. Provide stripping and seals for interior doors where scheduled in List of Door Hardware Items at end of Part 3.
2. Continuity of Stripping: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
4. Provide bumper-type weather-stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
 - a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
 - b. Dimensions: 1-3/8-inches by 7/8-inches, stop-mounted.
 - c. Seals: Closed-cell extruded silicone.
 - d. ANSI/BHMA: A156.22, R3E264.

- e. Products and Manufacturers: Provide one of the following:
 - 1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
 - 2) Or approved equal.
- 5. Provide heavy-duty automatic drop-seal sound-stripping door-bottom unit of manufacturer's standard design, with operating seal bar of the following material, retained in an extruded metal bar and capable of operating to close a 3/4-inch gap (from door bottom to floor or threshold). House mechanism and operating bar in the following metal housing, for mounting in doors as follows:
 - a. Housing: Extruded aluminum, 0.062-inch thick, with mill aluminum finish.
 - b. Seal: Closed-cell extruded silicone.
 - c. Mounting: Full-mortise.
 - d. ANSI/BHMA: A156.22, R3E344.
 - e. Products and Manufacturers: Provide one of the following:
 - 1) No. 434APKL by Pemko Manufacturing Company.
 - 2) Or approved equal.
- I. Thresholds:
 - 1. All exterior and interior doors shall be provided with thresholds.
 - 2. Metal: Mill finish extruded bronze.
 - 3. Surface Pattern: Fluted tread, manufacturer's standard.
 - 4. Provide countersunk stainless steel screws and expansion shields.
 - 5. Width: Five-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around door frames.
 - 6. Construction:
 - a. Single-piece, complying with manufacturer's recommendations.
 - 7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
 - a. Floor Drop: Except where no change in floor elevation is shown from one side of threshold to the other, provide profile that accommodates 1/2-inch drop in floor elevation, unless another dimension is shown.
 - b. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.
 - 8. Thickness: 1/2-inch, minimum.
 - 9. ANSI/BHMA: A156.21, J12100.

10. Products and Manufacturers: Provide one of the following:

- a. 171B by Pemko Manufacturing Company.
- b. Or approved equal.

J. Silencers:

- 1. Provide silencers for all door frames.
- 2. Provide pneumatic design that, once installed, forms an air pocket to reduce noise.
- 3. Provide minimum of three per strike side of door jambs.
- 4. ANSI/BHMA: A156.16, BHMA 6.5, L03011.
- 5. Products and Manufacturers: Provide one of the following:
 - a. GJ 64 by Glynn-Johnson Part of Worldwide Ingersoll-Rand.
 - b. Or approved equal.

K. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.

2.03 HARDWARE FINISHES

- A. Provide matching finishes for door hardware units at each door or opening, to the greatest extent possible in compliance with ANSI/BHMA A156.18.
- B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of door hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

PART 3 EXECUTION

3.01 INSPECTION

- A. CONTRACTOR shall examine the substrate to receive door hardware, and the conditions under which the Work will be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do not proceed with the door hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 PREPARATION

- A. Templates: Furnish door hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of door hardware. Check the Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the door hardware.
- B. Prepare Work to receive door hardware Work in compliance with ANSI/DHI A115.1.

3.03 INSTALLATION

- A. Installer shall check and approve the installation before operation. Installer shall assure that the system operates to the OWNER'S satisfaction.

- B. Mount door hardware units at heights recommended in, Door and Hardware Institute, "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames" and "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the Site, HMMA 830 and ADAAG requirements.
- C. Install each door hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install door hardware onto or into surfaces that are later to be painted or finished in another way, install each item completely, then remove, and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- F. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel that will not corrode in contact with the threshold metal.
- H. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.
- I. Adjust and check each operating item of door hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.
- J. Final Adjustment: Where door hardware installation is made more than one month prior to beneficial use, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all door hardware items in each space and area. Clean and re-lubricate operating items as necessary to restore proper function and finish of door hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.
- K. Provide manufacturer's authorized representative to instruct and train OWNER'S personnel in proper adjustment and maintenance of door hardware during the final adjustment of door hardware.
- L. Door hardware, which is blemished or defective, will be rejected even though it was set in place before defects were discovered. Remove and replace with new door hardware. Repair all resultant damage to other Work.

- M. Continued Maintenance Service: Approximately six months after the acceptance of door hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and door hardware. Consult with and instruct OWNER'S personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace door hardware items that have deteriorated or failed due to faulty design, materials or installation of door hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the door hardware.

3.04 FIELD QUALITY CONTROL

- A. Provide a written field report, prepared by installer's architectural hardware consultant, identifying actual condition, location, manufacturer, and product designation for each item of door hardware actually present on each door at the Site, including whether door hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.
- B. Installer's hardware consultant shall provide opinions to, and assist ENGINEER in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with ENGINEER shall be included in written field report for submission to ENGINEER for review and approval at completion of door hardware installation.
- C. As part of written field report to be submitted to ENGINEER for approval, recommend remedial actions for Work not in compliance with these Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by ENGINEER and incorporated into the Work.

3.05 LIST OF DOOR HARDWARE ITEMS

- A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware functions and types provided are only a general guideline for the final Door Hardware Schedule. CONTRACTOR shall submit a Door Hardware Schedule acceptable to all governing authorities having jurisdiction at the Site.
- B. Provide the following door hardware items:
 - 1. Door, Exterior, 4'-0" x 7'-1", Hollow Metal Door, Frame and Finish Hardware Assembly.
 - a. Mortise Hinges.
 - b. Panic Exit Device.
 - c. Overhead, Surface-Mounted Door Closers.
 - d. Heavy-Duty, concealed, adjustable, overhead holders and stops.
 - e. Stripping and Seals.
 - f. Protection Armor.
 - g. Threshold.
 - h. Silencers.

END OF SECTION 08710

SECTION 09900

PAINTING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
 - a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.
2. Extent of painting includes the Work specified below. Painting shown in schedules may not provide CONTRACTOR with complete indication of all painting Work. Refer to Article 2.02 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
 - a. All new and specifically identified existing surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or is specifically indicated in the Contract Documents as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
 - b. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown or specified.
 - c. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.
 - d. Approved stepped-down mock-ups for all painting systems showing all components of the surface preparation and paint system application before start of Work. Check all dry film thicknesses; demonstrate methods of surface preparation, and methods of application, and obtain ENGINEER's approval of colors and textures to be used in the Work.

B. Coordination:

1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
3. Coordinate primers with finish paint materials to provide primers that are compatible with finish paint materials.

4. Furnish information to ENGINEER on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 07920, Joint Sealants.
3. Section 08115, Hollow Metal Doors and Frames.

D. Work Not Included: The following Work is not included as painting Work:

1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections.
2. Pre-finished Items:
 - a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by CONTRACTOR using manufacturer's recommended compatible field-applied touchup paint.
 - b. Items furnished with finishes such as chrome plating or anodizing.
3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases and duct shafts.
4. Concrete floors, unless specifically shown as a surface to be painted.
5. Face brick and glazed structural tile.
6. Exterior face of architectural precast concrete.
7. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
8. Operating Parts and Labels:
 - a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
 - b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
 - c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings, and splatter that comes in contact with such labels.

9. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
10. Existing structures, equipment, and other existing surfaces and items unless otherwise shown or specified.

E. Description of Colors and Finishes:

1. Color Selection:
 - a. ENGINEER reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to OWNER.
2. Color Coding of Equipment, and Ducts:
 - a. In general, color-coding of equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1 and 40 CFR 1910.144.
 - b. For equipment on roofs or exposed to view, such as on exterior building facades and in offices and lobbies, color shall be selected by ENGINEER.
3. Color Coding of Equipment:
 - a. Finish coats of paint for equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety colors per ANSI Z535.1, Recommended Standards for Water Works; Recommended Standards for Wastewater Facilities, color specifications for safety colors and other primary colors:

**TABLE 09900-A
TABLE OF STANDARD COLORS**

<u>Item to be Painted</u>	<u>Designation*</u>
New Interior CMU Wall Surfaces	Match Existing
Hollow Metal Door and Frame	Match Existing

*Provide color samples with Shop Drawing submittal for direct color comparisons of color numbers available from manufacturer submitted, with closest matching color to be approved by Owner.

4. After approval by ENGINEER of colors and Shop Drawings and prior to commencing painting Work, ENGINEER will furnish color schedules for surfaces to be painted.

F. Abbreviations and Symbols:

1. Abbreviations and symbols used in painting systems are explained in Article 2.02 of this Section and provide information on generic composition of required materials, manufacturers, number of coats and dry mil film thickness per coat (DMFTPC), and coverage for determining required number of gallons for the Work.

1.02 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:

1. ANSI A13.1, Scheme for Identification of Piping Systems.
2. ANSI Z535.1, Safety Color Code.
3. ANSI/NSF Standard 60, Drinking Water Treatment Chemicals - Health Effects.
4. ANSI/NSF Standard 61, Drinking Water System Components – Health Effects.
5. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
6. ASTM D2200, Pictorial Surface Preparation Standards for Painting Steel Surfaces.
7. ASTM D4258, Practice for Surface Cleaning Concrete for Coating.
8. ASTM D4259, Practice for Abrading Concrete.
9. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
10. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
11. ASTM D4285, Test Method for Indicating Oil or Water in Compressed Air.
12. ASTM D4417, Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
13. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
14. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
15. AWWA C652, Disinfection of Water-Storage Facilities.
16. AWWA D102, Coating Steel Water-Storage Tanks.
17. Green Seal, Inc. Paint, (GS-11).
18. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
19. GLUMRB, Recommended Standards for Wastewater Facilities.
20. National Association of Piping Fabricators, NAPF 500-03, Surface Preparation Standard For Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings And/or Special Internal Linings.
21. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.
22. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

23. SSPC SP 1, Solvent Cleaning.
24. SSPC SP 3, Power Tool Cleaning.
25. SSPC SP 6, Commercial Blast Cleaning.
26. SSPC SP 10, Near-White Blast Cleaning.
27. SSPC SP 11, Power Tool Cleaning To Bare Metal.
28. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
29. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
30. SSPC Volume 2, Systems and Specifications.
31. U.S. Green Building Council, "LEED Reference Guide," Version 2.2, Credit 4.2.

1.03 DEFINITIONS

A. Standard coating terms defined in ASTM D16 apply to this Section, including:

1. Paint: Pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate, or finish coats.
2. Exposed: All items not covered with cement plaster, concrete, or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces include areas visible after permanent or built-in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, and similar covering products are in areas scheduled to be painted.
3. LEED Compliant: As defined by the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), means interior field-applied coatings that shall have a maximum volatile organic compound (VOC) and chemical content as listed in Green Seal, Inc. Paints (GS-11).
4. Low VOC: All interior and exterior field-applied coatings that have maximum VOC content as listed in OTC Model Rule for Architectural and Industrial Maintenance Coatings.
5. OTC: Ozone Transport Commission, which recommends standard VOC content levels in several Northeastern and Mid-Atlantic states.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Engage a single applicator that regularly performs installation of paint materials, with documented skill and successful experience in installing types of products required and that agrees to employ only trained, skilled tradesmen who have successful experience in installing types of products specified.
2. Submit name and qualifications to ENGINEER along with following information for at least three successful, completed projects:
 - a. Names and telephone numbers of owner and design professional responsible for project.

- b. Approximate contract cost of paint products.
 - c. Amount of area painted.
- 3. Submit to ENGINEER proof of acceptability of applicator by manufacturer.
- B. Testing Agency Qualifications: Provide an independent testing agency for testing specified in this Section. Testing agency shall be selected by OWNER and paid for by CONTRACTOR. When requested, submit documentation demonstrating to satisfaction of ENGINEER, that testing agency has experience and capability to satisfactorily conduct testing required without delaying the Work, in accordance with ASTM E329.
- C. Source Quality Control:
 - 1. Obtain materials from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work, to advise on products, mock-ups, installation, and finishing techniques and, at completion of Work, to advise ENGINEER on acceptability of completed Work and during the course of the Work as may be requested by ENGINEER.
 - 2. Certify long-term compatibility of all coatings with surfaces.
 - 3. Do not submit products that decrease number of coats, surface preparation, or generic type and formulation of coatings specified. Products exceeding VOC limits and chemical content specified will not be approved.
 - 4. ENGINEER may review manufacturers' recommendations concerning methods of installation and number of coats of paint for each painting system. CONTRACTOR shall prepare construction costs based on painting systems, number of coats, coverages and installation methods specified.
 - 5. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
 - 6. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in all painting systems.
 - 7. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services to be painted. Comply with:
 - a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by authorities having jurisdiction.
 - b. Areas subject to hydrogen sulfide fume exposure will be identified by ENGINEER. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in such areas.
 - c. Manufacturer shall identify colors that meet the requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water being prepared for use as potable water.
 - d. Comply with paint manufacturer's recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint.

8. Obtain each product from one manufacturer. Multiple manufacturing sources for the same system component are unacceptable.
9. Certify product shelf-life history for each product source for materials manufactured by the same manufacturer, but purchased and stored at different locations or obtained from different sources.
10. Constantly store materials to be used for painting Work between 60 degrees F and 90 degrees F, and per paint manufacturer's written recommendations, for not more than six months. Certify to ENGINEER that painting materials have been manufactured within six months of installation and have not, nor will be, subjected to freezing temperatures.

D. Regulatory Requirements:

1. Comply with VOC content limits of OTC Model Rule for Architectural and Industrial Maintenance Coatings:
 - a. Industrial Maintenance Coatings: 340 grams per liter.
 - b. Interior and Exterior Non-Flat Coatings: 250 grams per liter.
2. Comply with the following:
 - a. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards.
 - b. 40 CFR, Subpart D-2001, National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - c. Resource Conservation and Recovery Act of 1976 (RCRA).
 - d. SW-846, Toxic Characteristic Leaching Procedure (TCLP).
3. Comply with authorities having jurisdiction at Site for blast cleaning, confined space entry, and disposition of spent abrasive and debris.

E. Stepped-down Mock-ups:

1. Demonstrate installation of specified painting systems on actual wall surfaces and building components at locations selected by ENGINEER.
2. Provide 4-foot by 8-foot stepped-down sample area for each painting system. Prior to application of painting system, but after ENGINEER's approval of the components of each painting system, apply a 4-foot wide sample of each operation and application step required by this Section and specified manufacturer's written application recommendations. Show each application step as a 2-foot long section that shall remain exposed to demonstrate work performed in that step. Continue application procedures until topcoat is provided. Topcoat shall be a minimum of two feet long. When completed, finished mock-up for each paint system shall reveal each step and each coat of paint required for paint system with 2-foot wide strips revealing Work performed to prepare surface and apply each coat. Lengthen overall mock-up as required to completely demonstrate each painting system. Use tinted shades differing from coat to coat for each component of each painting system.
3. ENGINEER may approve or disapprove each component of each painting system on an individual component basis.
4. Painting Work that does not meet standard approved on sample areas shall be removed and replaced.

5. Painting Work advanced without approved mock-ups shall stop, and mock-ups prepared for approval by ENGINEER.

1.05 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

- a. Copies of manufacturer's technical information and test performance data, including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contract Documents, and application instructions for each product proposed for use.
- b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.
- c. Copies of CONTRACTOR's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
- d. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied. Identify by manufacturer's catalog number and general classification. State number of gallons of each product being purchased for delivery to Site and square foot area calculated to be covered by each painting system specified based on theoretical loss of 20 percent. Where actual area to be covered by paint system exceeds area submitted to ENGINEER for that system, proof of additional material purchase shall be provided to ENGINEER. Calculated coverage shall be as specified for each component of each painting system specified. This requirement does not take precedence over CONTRACTOR's responsibility to provide dry film thickness required for each component of each painting system.
- e. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
- f. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.
- g. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.

2. Samples:

- a. Copies of manufacturer's complete color charts for each coating system.
- b. Mock-ups specified for the Site.

B. Informational Submittals: Submit the following:

1. Certificates:

- a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.
- b. Evidence of shelf-life history for all products verifying compliance with the requirements of the Contract Documents.
- c. CONTRACTOR shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.

2. Test Reports:

- a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.
- b. Adhesion testing plan and procedures.
- c. Results of adhesion testing on existing surfaces containing paints or other coatings to be topcoated with paint systems specified. Prior to adhesion testing, submit a testing plan establishing methods, procedures and number of tests in each area where existing coatings are to remain and become substrate for painting Work. Based on results of adhesion testing, recommend methods, procedures, and painting system modifications, if necessary, for proceeding with Work.
- d. Locations of and test methods for soil sampling before beginning Work and after beneficial use.
- e. Proposed methods for testing, handling, and disposal of waste generated during Work.
- f. Results of alkalinity and moisture content tests performed in accordance with ASTM D4262 and ASTM D4263.
- g. Results of tests of film thickness, holidays, and imperfections.

3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.

4. Manufacturer's Site Reports: Provide report of paint manufacturer's representative for each visit to Site by paint manufacturer's representative.

5. Special Procedure Submittals:

- a. Proposed protection procedures for each area of Work, explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption.

- b. Site-specific health and safety plan.
 - c. Procedures for maintaining acceptable application, curing and environmental conditions during and after painting systems application.
 - d. Procedures for providing adequate lighting, ventilation, and personal protection equipment relative to painting Work.
 - 6. Qualifications:
 - a. Applicator.
 - b. Testing laboratory
- C. Closeout Submittals: Submit the following:
 - 1. Maintenance Manual: Upon completion of the painting Work, furnish ENGINEER five copies of detailed maintenance manual including the following information:
 - a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
 - b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
 - c. Detailed procedures for routine maintenance and cleaning.
 - d. Detailed procedures for light repairs such as dents, scratches and staining.
 - 2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to ENGINEER signed by CONTRACTOR and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
 - 1. Container contents, including name and generic description of product.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Manufacturer's name.
 - 4. Contents by volume, for major pigment and vehicle constituents.
 - 5. Grams per liter of volatile organic compounds.
 - 6. Thinning instructions, where recommended.
 - 7. Application instructions.
 - 8. Color name and number.

B. Product Storage Requirements:

1. Store acceptable materials at Site.
2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
3. Store products that are not in actual use in tightly covered containers.
4. Comply with health and fire regulations of authorities having jurisdiction at Site.

C. Product Handling Requirements:

1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.07 SITE CONDITIONS

A. Site Facilities:

1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system application, are not available at Site.
2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance and temperature monitoring personnel is the responsibility of CONTRACTOR.
3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent such heat sources to exterior such that paint systems are unaffected by exhaust.

B. Existing Conditions:

1. Existing surfaces to receive painting Work shall be surface-prepared to meet requirements of painting systems specified. Prior to commencing painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be sufficient to determine condition of existing coatings and suitability of existing coatings to remain to provide acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER a copy of adhesion test results.
2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA) filters and dust containment systems.

C. Environmental Requirements:

1. Apply water-base paints when the temperature of surfaces to be painted and ambient air temperatures are between 55 degrees F and 90 degrees F, unless otherwise permitted by paint manufacturer's published instructions.
2. Surfaces to be painted shall be at least 5 degrees F above dew point temperature and be dry to the touch. Apply paint only when temperature of surfaces to be painted, paint products, and ambient air temperatures are between 65 degrees F and 95 degrees F, unless otherwise permitted by paint manufacturer's published instructions.
3. Apply paint system within shortest possible time consistent with manufacturer's recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, remove contamination per SSPC SP 1 and restore surface before applying paint.
4. Do not paint tanks or pipelines containing fluid without specific permission of ENGINEER and only under conditions where "sweating" of outside surface of vessel being painted is not likely to occur within 24 hours of paint application.
5. Do not apply epoxy paints if ambient temperature is expected to go below 50 degrees F within twelve hours of application. Follow manufacturer's instructions when manufacturer's published recommendations require a higher minimum ambient temperature.
6. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent. Do not apply paint to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during course of paint application, unless otherwise permitted by paint manufacturer's published instructions.
7. Do not paint unacceptably hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to paint manufacturer. Arrange for surfaces to be brought within acceptable temperature and dew point ranges as part of painting Work.
8. Moisture content of surfaces shall be verified to ENGINEER as acceptable prior to commencement of painting using methods recommended by paint manufacturer.
9. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer for application and drying.
10. Provide adequate illumination and ventilation where painting operations are in progress.

D. Protection:

1. Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently, or not to be painted.
2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.

4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until ENGINEER accepts protection techniques proposed by CONTRACTOR.
5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

E. Testing:

1. Perform testing of waste materials and existing paint required under Federal, state, or local regulations not specifically addressed in this Section.

1.08 MAINTENANCE

- A. Extra Materials: Furnish, tag, and store an additional one percent by volume of all coatings and colors installed. Provide a minimum of one gallon of each coating and color. Store in unopened containers as specified until turned over to OWNER.

PART 2 – PRODUCTS

2.01 PAINTING SYSTEM MANUFACTURERS

- A. Products and Manufacturers: Where referenced under painting systems provide products manufactured by the following, or approved equal:

1. Tnemec Company, Inc. (TCI).
2. The Carboline Company, part of StonCor Group, an RMP Company (TCC).
3. Sherwin-Williams Company (SWC).
4. Benjamin Moore & Company (BMC).
5. ICI Paints (ICI).
6. Righter Group Inc. (RGI)
7. Duron Inc. (DI)

2.02 PAINTING SYSTEMS

- A. New and Existing Concrete Unit Masonry Walls; Moderate Corrosion and Abrasion Resistant, Non-submerged, Interior:

1. Surface Preparation: Refer to Paragraphs 1.05.A.2., 3.02.A., 3.02.B.1., 3.02.B.2 and 3.02.B.8.
2. Filler, Surface, and Patching Compound:
 - a. Generic Components:
 - 1) Minimum 68 percent volume solids, high-build, three-component, waterborne cementitious acrylic block filler; 75 grams per liter VOC, maximum.

- b. Products and Manufacturers: Provide one of the following:
 - 1) Series 130 Envirofill (TCI); Sanitile 600 TG (TCC); Cement-Plex 875 (SWC); One Coat, 10 to 14 dry mils.
 - 3. Intermediate/Finish:
 - a. Generic Components:
 - 1) Minimum 80 percent volume solids, high-build, chemical-resistant, high-gloss, modified polyamine or polyamide-amine catalized epoxy finish; 180 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 280 Tneme-Glaze (TCI); Carboguard 890 LT (TCC); Cor-Cote HP (SWC):
 - a) Vertical Surfaces: Two coats, 4.0 to 8.0 dry mils, per coat.
- B. New and Existing Ferrous Metals, Non-Ferrous Metals and Exterior Surfaces of Piping; Submerged or Intermittently Submerged, including up to 4.0 feet above liquid surface; Interior and Exterior:
 - 1. Surface Preparation: Refer to Paragraphs 1.05.A.2., 3.02.A., 3.02.C.1., 3.02.C.2., and 3.02.E.
 - 2. Factory Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent solids, two-component, cycloaliphatic amine- catalyzed epoxy or polyamido-amine epoxy; 334 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 954 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 4.0 dry mils.
 - 3. Shop Prime/Touch-Up/Finish, Satin:
 - a. Generic Components:
 - 1) Minimum 100 percent volume solids, high-build, two-component, polyamide-catalyzed epoxy or polyamido-amine epoxy; 10 grams per gallon VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series N69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Dura-Plate UHS (SWC): Three coats, 8.0 to 15.0 dry mils, per coat.
- C. New and Existing Ferrous Metals, Non-Ferrous Metals, and Galvanized Metals, including Water Storage Tanks; Non-Submerged, Exterior:
 - 1. Surface Preparation: Refer to Paragraphs 1.05.A.2., 3.02.A., 3.02.C.1., 3.02.C.2., 3.02.D., 3.02.E. and 3.02.F.

2. Ferrous Metal Shop Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent solids, polyamidoamine epoxy; 296 grams per liter, VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series V69 Hi-Build Epoxoline (TCI); Carboguard 954 (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
3. Galvanized and Non-Ferrous Shop Primer:
 - a. Generic Components:
 - 1) Refer to Paragraph 2.02.F.2.a.1), above.
 - b. Product and Manufacturer: Provide one of the following:
 - 1) Refer to Paragraph 2.02.F.2.b.1), above.
4. Intermediate (Ferrous Metals Only):
 - a. Generic Components:
 - 1) For Low-temperature Curing Conditions: Minimum 75 percent solids, cycloaliphatic amine or polyamine epoxy; 296 grams per liter VOC, maximum.
 - 2) For Warm-temperature Curing Conditions: Minimum 75 percent volume solids, cycloaliphatic amine or polyamine epoxy; 296 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) For Low-temperature Curing Conditions: Series 136, Epoxoline HS (TCI); Carbguard 890 or 890 LT (TCC); Macropoxy HS (SWC): One coat, 10.0 dry mils.
 - 2) For Warm-temperature Curing Conditions: Series 166 Epoxoline HS (TCI); Carbguard 890 or 890 LT (TCC); Macropoxy HS (SWC): One coat, 6.0 dry mils.
5. Finish: Semi-Gloss:
 - a. Generic Components:
 - 1) Minimum 65 percent solids, aliphatic acrylic polyurethane; 340 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series V73 Endura-Shield (TCI); Carbothane 133 VOC (TCC); Hi-Solids Aliphatic Acrylic Polyurethane (SWC): Two coats, 2.0 dry mils, per coat, 310 square feet per gallon.

D. New and Existing Galvanized Metal, Non-Ferrous Metal, and Fiberglass; Non-submerged, Interior:

1. Surface Preparation: Refer to Paragraphs 1.05.A.2., 3.02.A., 3.02.D., 3.02.E. and 3.02.F.
2. Primer:
 - a. Generic Components:
 - 1) Minimum, 39 percent volume solids single-component, self-cross linking acrylic primer-sealer, 140 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 115 Uni-Bond DF (TCI); Galoseal Wash Primer (TCC); Pro-Cryl Universal Primer (SWC): One coat, 2.0 to 4.0 dry mils.
3. Finish: Satin:
 - a. Generic Components:
 - 1) Minimum, 41 percent volume solids, single component, self-cross linking acrylic; 208 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 116 Uni-Bond (TCI); Carbocrylic 3359 (TCC); DTM Acrylic Coating (SWC): One coat, 2.0 to 4.0 dry mils.

2.03 CALKING AND SEALANTS

- A. Refer to Section 07920, Joint Sealants.

2.04 INSTRUMENTS

A. Instruments:

1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocks.
2. Products and Manufacturers: Provide the following:
 - a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, Or approved equal.
 - b. Holiday detector shall be Model M-1 as manufactured by Tinker & Rasor, Or approved equal.
 - c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which painting Work is to be performed 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. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film capable of performing in accordance with claims made in paint manufacturer's product literature for surfaces and conditions encountered.
- C. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.02 SURFACE PREPARATION

- A. General:
 - 1. Test for moisture content of surfaces before commencement of painting Work. Test for moisture in concrete in compliance with ASTM D4263. Report results to ENGINEER before commencing Work.
 - 2. Prepare existing surfaces to be painted as specified for new surfaces. Submit substitute methods of preparing existing surfaces, when proposed, with Shop Drawing submittal. ENGINEER's acceptance of substitute surface preparation methods does not relieve CONTRACTOR of performance required under the Contract Documents. To provide surfaces acceptable for application of painting system specified:
 - a. Clean and roughen surfaces of existing paint and other decorative or protective toppings on surfaces to remain that are to receive a painting system under this Section.
 - b. Where existing surfaces to be painted have corrosion, peeling paint, or unacceptably adhering coatings, remove all topcoats, primers, and intermediate coats of paint, and other protective or decorative coatings.
 - 3. Perform preparation and cleaning procedures as specified herein and in strict accordance with paint manufacturer's approved instructions for each surface and atmospheric condition.
 - 4. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in place that do not require field painting, or provide effective surface-applied protection prior to surface preparation and painting.
 - 5. Remove as necessary items that must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved.
 - 6. Clean surfaces to be painted before applying painting system components. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.
 - 7. Prepare surfaces that were improperly shop-painted and abraded or rusted shop-painted surfaces as specified.

B. Cast-In-Place Concrete:

1. Prepare surfaces of concrete unit masonry to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and other contamination using soap and water. Surfaces shall be clean and dry at time of paint system application.
2. Concrete unit masonry that cannot be adequately cleaned using soap and water shall be acid etched with a commercial solution of 15 percent muriatic acid.
3. Prepare and clean cast-in-place concrete and precast concrete surfaces per ASTM D4259 and ICRI CSP to provide a uniform and continuous anchor profile. Provide mechanical abrading and abrasive blasting per ASTM D4259. Use 40 to 80-mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be per ASTM D4285. Pressure at blasting nozzle shall not exceed 80 pounds per square inch. Do not concentrate blast on surface; instead, move at a fairly rapid rate to provide a surface free of laitants and contaminants. Provide post-surface preparation cleaning per ASTM D4258 to remove loose material. Surface preparation shall open all surface air holes by removing laitance shoulders surrounding air holes. Vacuum surfaces to remove dust and sand, and wash with potable water.
4. Where paint system is for chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radiused cove base fillets at equipment pads and containment walls as part of complete chemical containment paint system Work. Use materials and techniques recommended by manufacturers of the paint and concrete repair products.
5. Remove from cast-in-place concrete fins, projections, and other surface irregularities that would protrude above level of finished intermediate fillers and surfacers. Remove by chipping and scarification by mechanical abrasion.
6. Using specified filler and surfacer, patch cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions, grind filler and surfacing compounds smooth, and level with adjacent surfaces.
7. Perform tests per ASTM D4262 and ASTM D4263 to verify alkalinity and moisture content of surfaces to be painted, and report findings to ENGINEER. If, in ENGINEER's opinion, surfaces are sufficiently alkaline to cause blistering and burning of paint, correct the condition before applying paint. Provide suitable testing materials for alkalinity and moisture tests. Do not paint surfaces where the moisture content exceeds eight percent.
8. Where a concrete unit masonry block filler is specified, spot patch holes and cracks with a putty knife using specified block filler. Apply to large surfaces by airless spray and backroll uniformly using a roller with a synthetic nap cover. Follow with a rubber squeegee to provide a smooth finish.

C. Ferrous Metals:

1. Ferrous Metals Except Ductile and Cast Iron:
 - a. Comply with paint manufacturer's recommendations for type and size of abrasive to provide a surface profile that meets manufacturer's painting system requirements for type, function, and location of surface. Verify that paint manufacturer-recommended profiles have been achieved on prepared surfaces. Report profiles to ENGINEER using Test Method C of ASTM D4417.

- b. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale, and other contamination by commercial blast cleaning complying with SSPC SP 6 at time of paint system application, using SSPC VIS 1 as a standard of comparison.
 - c. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - d. Clean non-submerged, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale, and other contamination by commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - e. Clean submerged ferrous surfaces that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - f. Touch-up shop-applied prime coats that have damaged or have bare areas with primer recommended by paint manufacturer after commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison, to provide a surface profile of not less than one mil.
 - g. Power tool-clean per SSPC SP 3 to remove welding splatter and slag.
 - h. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool-cleaning complying with SSPC SP 11 to provide a surface profile of not less than one mil.
 - i. Cleaning: Clean tank to remove sediment and coarse debris, including aluminum or magnesium anode rods, from tank floor and other horizontal surfaces. Sediment and debris shall be removed and disposed of in accordance with local, state, and federal regulations.
- D. Non-Ferrous Metal Surfaces: Prepare non-ferrous metal surfaces for painting by light whip blasting or by lightly sanding with 60- to 80-mesh sandpaper.
- E. Galvanized (Zinc-Coated) Surfaces: Prepare galvanized surfaces for painting by lightly sanding with 60- to 80-mesh sandpaper or by light whip blasting.
- F. PVC and CPVC Piping and Fiberglass: Lightly sand and clean surfaces to be painted. Fiberglass surfaces shall be prepared by solvent washing to remove wax and other contaminants, before abrading surfaces with 60- to 80-mesh sandpaper to provide an anchor pattern with scratches no further apart than 1/16-inch.

3.03 PROTECTION OF PROPERTY AND STRUCTURES

- A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation and paint application.
- B. Use shrouding, vacuum blasting, or other approved methods for cleaning and surface preparation of exterior surfaces.
- C. During blast cleaning and surface preparation of interior and exterior surfaces, control discharge of dust and grit, using shrouding, negative-pressure containment/dust collection systems, or other

means to protect adjacent property and structures and prevent dust/grit from escaping. Similarly control removal and temporary storage of residues to protect adjacent property and structures.

- D. For painting of exterior surfaces, use rollers, shrouding or other approved methods as required to protect adjacent property and structures from wind-blown paint residues.
- E. Submit proposed procedures for cleaning, surface preparation and paint application describing methods for protecting adjacent property and structures from residues. Do not proceed with cleaning, surface preparation or painting until proposed procedures are approved by ENGINEER.

3.04 MATERIALS PREPARATION

A. General:

- 1. Mix and prepare paint products in strict accordance with paint manufacturer's product literature.
- 2. Do not mix painting materials produced by different manufacturers, unless otherwise permitted by paint manufacturer's instructions.
- 3. Where thinners are required, they shall be produced by paint system manufacturer unless otherwise permitted by paint manufacturer's product literature and submitted to and accepted by ENGINEER with Shop Drawings.

B. Tinting:

- 1. Where multiple coats of the same material are to be provided, tint each undercoat a lighter shade to facilitate identification of each coat of paint.
- 2. Tint undercoats to match color of finish coat of paint, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by manufacturer.

C. Mixing:

- 1. For products requiring constant agitation, use methods in compliance with manufacturer's product literature to prevent settling during paint application.
- 2. Mix in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect floors from slashes or spills that could stain the floor or react with subsequent finish floor material.
- 3. Mix and apply paint in containers bearing accurate product name of material being mixed or applied.
- 4. Stir products before application to produce a mixture of uniform density and as required during the application. Do not stir into the product film that forms on surface; instead, remove film and, if necessary, strain product before using.
- 5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50-mesh screen before application.

3.05 APPLICATION

A. General:

1. Apply paint systems by brush, roller, or airless spray per manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable. Use brushes best suited for type of paint applied. Use rollers of carpet, velvet back, or high pile sheep's wool as recommended by paint manufacturer for product and texture required. Use air spray and airless spray equipment recommended by paint manufacturer for specific painting systems specified. Submit a list of application methods proposed, listing paint systems and location.
2. Paint dry film thicknesses required are the same regardless of the application method. Do not apply succeeding coats until previous coat has completely dried.
3. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is uniform finish, color, and appearance, particularly for intense chroma primary colors. Ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a film thickness equivalent to that of flat surfaces.
4. Surfaces of items not normally exposed-to-view do not require the same color as other components of system of which they are part, but require the same painting system specified for exposed surfaces of system.
5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
6. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
7. Paint aluminum parts in contact with dissimilar materials with specified paint system.
8. Paint tops, bottoms, and side edges of doors the same as exterior surfaces.
9. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and manufacturer's recommended compatible field-applied finishes.
10. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

B. Minimum/Maximum Paint Film Thickness:

1. Apply each product at not less than, nor more than, manufacturer's recommended spreading rate, and provide total dry film thickness as specified.
2. Apply additional coats of paint if required to obtain specified total dry film thickness.
3. Maximum dry film thickness shall not exceed 100 percent of minimum dry film thickness, except where more stringent limitations are recommended by paint manufacturer for a specific product.

C. Scheduling Surface Preparation and Painting:

1. As soon as practical after preparation, apply first-coat material to surfaces that have been cleaned, pretreated, or otherwise prepared for painting. Apply first-coat material before subsequent surface deterioration due to atmospheric conditions existing at time of surface

preparation and painting. Surfaces that have started to rust before first-coat application is complete shall be brought back to required standard by abrasive blasting.

2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure and application of another coat of paint does not cause lifting or loss of adhesion to undercoat.
 3. Scarify primers and other painting system components by brush-blasting if paint has been exposed for lengths of time or under conditions beyond manufacturer's written recommendations for painting systems required, intended use, or method of application proposed for subsequent coats of paint.
 4. Schedule cleaning and painting so that dust and other contaminants from cleaning process do not fall on wet, newly painted surfaces.
- D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.
- E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.
- F. Brush Application:
1. Brush out and work all brush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
 2. Brush-apply primer or first coats, unless otherwise permitted to use mechanical applicators.
- G. Mechanical Applicators:
1. Use mechanical methods for paint application when permitted by governing ordinances, manufacturer, and approved by ENGINEER.
 2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.
 3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of multiple coats in one pass.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.06 FIELD QUALITY CONTROL

- A. ENGINEER may invoke the following material testing procedure at any time for a maximum of five times during field painting Work:
1. CONTRACTOR shall engage service of an independent testing laboratory to sample paints used, as designated by ENGINEER. Samples of products delivered to Site shall be obtained, identified, sealed, and certified as to being products actually applied to surfaces in each area, in presence of CONTRACTOR.
 2. A testing laboratory selected by OWNER and paid for by CONTRACTOR shall perform appropriate tests for any or all of the following:

- a. Abrasion resistance.
 - b. Apparent reflectivity.
 - c. Flexibility.
 - d. Washability.
 - e. Absorption.
 - f. Accelerated weathering.
 - g. Dry opacity.
 - h. Accelerated yellowness.
 - i. Recoating.
 - j. Skinning.
 - k. Color retention.
 - l. Alkali resistance.
 - m. Quantitative materials analysis.
3. If test results show that products being used do not comply with specified requirements, CONTRACTOR may be directed to stop painting Work and remove non-complying paint, and shall prepare and repaint surfaces coated with rejected paint with material complying with the Contract Documents.
- B. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Perform testing using testing instruments specified in Article 2.04 of this Section.
- 1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
 - 2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.
- C. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.
- D. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to ENGINEER.
- 3.07 PROTECTION OF NEW FINISHES
- A. Provide signs that read, "Wet Paint" as required to protect newly painted finishes. Remove temporary wrappings provided for protection of the Work and work of other contractors after completion of painting.

3.08 ADJUSTING AND CLEANING

- A. Correct damages to work of other trades through cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. During progress of Work, remove from Site all discarded paint materials, rubbish, cans, and rags at end of each workday.
- C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, while avoiding scratching or otherwise damaging finished surfaces.
- D. At completion of work of other trades, touch-up and restore damaged or defaced painted surfaces as determined by ENGINEER.

3.09 SCHEDULES

- A. The schedules listed below, following the "End of Section" designation, are a part of this Specification section.
 - 1. Table 09900-B, Painting Schedule.

END OF SECTION 09900

**TABLE 09900-B
PAINTING SCHEDULE**

Facility or Surface *	Room No.	Painting System **	Remarks
Hollow Metal Door and Frame	Electrical Room	C	Color closest to existing to be approved by Owner from submitted manufacturer's color chart.
New Interior CMU Surfaces	Electrical Room	A	Color closest to existing to be approved by Owner from submitted manufacturer's color chart.

* Refer to Drawings for facility locations and for facilities not listed above.

** Refer to Article 2.02 of this Section.

NO TEXT ON THIS PAGE

SECTION 13400

INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a relay panel shown on the electrical drawings, and all primary sensors and field instruments, and interconnecting required field signal wiring. Contractor shall coordinate with the Owner for interfacing new field instruments and field wiring to the existing Pump Station Control System.
2. Contract Documents illustrate and specify functional and general construction requirements of the relay panel, sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. CONTRACTOR shall provide all components, piping, wiring, accessories, and labor required for a complete, workable, and integrated system.

B. Coordination:

1. Instrumentation and Controls:
 - a. Programming of control logic and configuration of HMI software is not part of the Work and is by OWNER assigned Programmer.
 - b. Some equipment are furnished under other Specification Sections under this Contract. CONTRACTOR shall coordinate with Suppliers of these panels and equipment to provide fully functional system in accordance with the Contract Documents and that interfaces with PHPS.
2. To the greatest extent possible, provide materials and equipment from a single manufacturer.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 16349, Medium-Voltage Motor Starters

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ISA 5.1, Instrumentation Symbols and Identification.
2. ISA 5.4, Instrument Loop Diagrams.
3. ISA 20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.

4. NFPA 79, Standard for Industrial Machinery.
5. UL 50, Standard for Enclosures for Electrical Equipment.
6. UL 508A, Standard for Industrial Control Panels.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Acceptable Manufacturers:

- a. Furnish primary process measurement devices by the named manufacturers or equal that match all features, quality, life expectancy and workmanship of the specified unit.
- b. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
- c. Obtain all sensors and field instruments of a given type from the same manufacturer.
- d. Manufacturer: Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced in producing similar equipment and shall have the following qualifications:
 - 1) Shall manufacture instrumentation and control system components that are fully developed, field-proven, and of standardized designs.
 - 2) Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
 - 3) Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
 - 4) Shall have documented product safety policy relevant to products proposed for the Work.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Product information for field instruments, including:
 - 1) Manufacturer's product name and complete model number of device being provided, including manufacturer's name and address.
 - 2) Instrument tag number from Contract Documents.
 - 3) Data sheets and manufacturer's catalog literature. Provide data sheets as shown in ISA 20 and annotated for the features being provided for this project. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.

- 4) Description of construction features.
 - 5) Performance and operation data.
 - 6) Installation, mounting, and calibration details; instructions and recommendations.
 - 7) Service requirements.
 - 8) Range of each device and calibration information
 - 9) Descriptions of materials of construction and a listing of NEMA ratings for all equipment
- b. Panel and Cabinet Information:
- 1) Layout Drawings include the following:
 - a) Front, rear, and internal panel views to scale.
 - b) Dimensional information.
 - c) Tag number and functional name of components mounted in and on panel, console or cabinet.
 - d) Product information on all panel components.
 - e) Nameplate location and legend including text, letter size and colors to be used.
 - f) Location of anchoring connections and holes.
 - g) Location of external wiring and/or piping connections.
 - h) Mounting and installation details.
 - 2) Wiring and/or piping diagrams include the following:
 - a) Name of panel, console or cabinet.
 - b) Wiring sizes and types.
 - c) Piping sizes and types.
 - d) Terminal strip numbers.
 - e) Wire color coding.
 - 3) Electrical control schematics in accordance with NFPA 79 Standards for all circuits indicated in the Contract Documents. No typical wiring diagrams will be acceptable and no tables or charts to describe wire numbers will be acceptable.
 - 4) Stock list or Bill of Materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for all components mounted in or on the panel or enclosure.

2. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
 - B. Closeout Submittals: Submit the following:
 1. Operation and Maintenance Data:
 - a. Submit in accordance with Section 01782, Operations and Maintenance Data.
 - b. Include acceptable test reports, maintenance data and schedules, description of operation, and wiring diagrams.
 2. Record Documentation:
 - a. Prepare and submit record documents in accordance with Section 01780 Project Record Documents.
 - b. Revise all system Shop Drawing submittals to reflect as-built conditions.
- 1.05 STORAGE AND HANDLING
- A. Each manufacturer or supplier shall securely attach the tag number and instructions for proper field handling and installation to each instrument. Comply with Section 01600 Materials and Equipment.

PART 2 - PRODUCTS

2.01 GENERAL SYSTEM REQUIREMENTS

- A. Power Supplies:
 1. A power on-off switch or an air circuit breaker shall be furnished for each item requiring electrical power.
- B. Signal Requirements:
 1. The instrumentation system shall be designed to use 4 to 20 mA DC analog signals, unless otherwise specified.
 2. Provide signal converters and repeaters where required.
 3. Discrete signals shall use 24 VDC.
- C. Miscellaneous:

1. General:

- a. Instrumentation components shall be heavy-duty types, designed for continuous service.
 - b. System shall consist of equipment models which are currently in production.
 - c. Materials and equipment, including cable and interconnections, shall be in accordance with Division 16, Electrical, and manufacturer's recommendations, unless specified otherwise in the Contract Documents.
 - d. Materials and equipment shall, where applicable, be in accordance with standards of Underwriters Laboratories (UL), Inc., and be so marked or labeled.
3. Field-mounted instruments and system components shall be designed for installation in humid and corrosive service conditions. Field mounted instrument enclosures, junction boxes and appurtenances shall conform to the NEMA ratings that meet hazardous rating requirements shown on drawings and instrument data sheets.
4. Miscellaneous hardware such as fittings, fasteners, screws, etc., shall be of Type 316 stainless steel or appropriate material to prevent galvanic reactions and shall be suitable for service intended. Pipe stands shall be provided for fastening of instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges with painting conforming to Section 09900, Painting.
5. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actually furnished for operability over the intended range. Complete the coordination prior to submitting Shop Drawings to ENGINEER.
6. Treat field-mounted devices with anti-fungus spray.
7. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

D. Environmental Conditions:

1. The instrumentation system shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
 - a. Indoor instruments:
 - 1) Ambient Temperature: 0 F to 120°F.
 - 2) Relative Humidity: 100 percent, maximum.
 - b. Outdoor instruments
 - 1) Ambient Temperature: -15 F to 120°F.
 - 2) Relative Humidity: 100 percent, maximum.

2. Field instruments mounted outdoors shall be protected from direct sunlight by a sunshade. The sunshade shall be constructed out of non-corrosive material and shall withstand a wind velocity of 130 miles per hour.

2.02 PANELS (Relay Panel)

A. General Provisions:

1. Provide electrical components and devices, support hardware, fasteners, and interconnecting wiring and piping required to provide control panels complete and operational.
2. Locate and provide hardware so that connections can be easily made and there is ample room for servicing each item.
3. Prevent movement by adequately supporting and restraining devices and components mounted on or within panel.
4. Provide numbered terminal strips for terminating field wiring and wiring from other panels, unless otherwise shown or indicated.
5. Provide copper grounding studs for hardware requiring grounding.
6. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
7. CONTRACTOR is responsible for detailed layout and design of panels, in accordance with the Contract Documents. Base cutouts and design on instrument manufacturers' requirements.
8. Do not locate front panel-mounted devices requiring manipulation by operating personnel, such as pushbuttons, hand switches, controllers, and similar devices, higher than 5.5 feet above finished floor.
9. Panels shall be UL-listed.

B. Identification:

1. Provide laminated plastic nameplate for identification of panels. Use self-tapping stainless steel screws for fastening nameplates to panels. When self-tapping screws may degrade panel's NEMA rating, retain NEMA rating intact by using gaskets on each side of panel surface and use retaining plate on the panel back that is same size as nameplate. When gaskets and retaining plate are used, use full-penetration screws with nuts.
2. Panel identification nameplates shall have 1/2-inch high engraved letters.
3. Identify front panel-mounted devices with nameplates engraved with functional description of the device.
4. Tag electric components and devices mounted within panels with high adhesive labels.
5. Identify terminal strips with nameplate engraved as "TB-XX" where "XX" is the numerical identification of terminal strip.

6. Identify terminals within each terminal strip with sequential numbers and wire numbers.
7. Internal panel wiring shall be color-coded and numerically identified with unique wire numbers affixed at each end of each wire. Color coding shall be in accordance with panel wiring color code table, below:

Panel Wiring Color Code Table

Description	Color
110 VAC panel power before fuses or breakers	Black
Controlled 110 VAC power (e.g., after relay contacts, selector switch contacts, and similar equipment.)	Red
110 VAC power source from devices external to panel	Yellow
110 VAC neutral	White
24 VDC positive power from power supplies	Blue
24 VDC negative power from power supplies	Brown
Controlled 24 VDC power (e.g., after PLC output contacts, relay contacts, and similar)	Orange
24 VDC positive power from devices external to panel	Orange
24 VDC negative power from devices external to panel	Brown
24 VDC four to 20 mA DC signal cable	Grey with red positive, clear negative
Grounding wire	Green

C. Panel Construction Features:

1. Panels located inside control or electric room areas shall be rated NEMA 12 with the following features:
 - a. Fabricate enclosures using minimum 14-gage steel for wall- or frame-mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Continuously weld exterior seams and grind smooth. Surface grind panel to completely remove corrosion, burrs, sharp edges, and mill scale.
 - c. Reinforce sheet steel with steel angles where required to adequately support devices and equipment and ensure rigidity and to preclude resonant vibrations.
 - d. Panel shall be flat within tolerance of 1/16-inch over two-foot by two-foot area, or flat within tolerance of 1/8-inch for larger surface area. Acceptable out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
 - e. Use pan type construction for doors. Door widths shall not exceed three feet.
 - f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
 - g. Provide oil resistant gasket completely around each door or opening.
 - h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.

- i. Use stainless steel fasteners throughout.
- j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with white enamel finish.
- k. For prints, provide steel pocket with white enamel finish.
- l. Provide enclosure mounting supports as required for floor, frame, or wall mounting as required.
- m. Completely clean interior and exterior surfaces so surfaces are free of corrosive residue, oil, grease, and dirt. Zinc phosphatize for corrosion protection.
- n. Provide one coat of primer paint to interior and exterior surfaces immediately after applying corrosion protection, in accordance with coating manufacturers' instructions. Provide surface preparation in accordance with coating manufacturer's requirements.
- o. Paint interior surfaces with two coats of semi-gloss white polyurethane enamel.
- p. Paint exterior surfaces with minimum of three finish coats of polyurethane enamel to produce a finish that is smooth and free of imperfections. Color shall be selected by ENGINEER from complete selection of standard and custom color charts furnished by manufacturer.
- q. Primer and finish paint shall be compatible and shall be low-VOC, high-solids polyurethane enamel.

D. Electrical Systems:

- 1. Power Source and Internal Power Distribution:
 - a. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
 - b. Protect incoming 120VAC power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
- 2. Wiring:
 - a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 volts at 85 degrees C for single conductors, color-coded and labeled with wire identification.
 - b. For DC signal wiring, use shielded cable with 18-gage conductors. DC field signal wiring terminal strips shall be capable of handling wires up and including No. 12 size.
 - c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by the NEC (NFPA 70).
 - d. Inside of panels, route DC signal wiring separately from power wiring with minimum separation distance of six inches.

- e. Terminate all internal panel wiring using screw type terminal blocks mounted on DIN rails. Fused terminal blocks shall have LED blown fuse indication. Terminal blocks for 4-20 mA signals shall be fused and knife disconnect terminal blocks. Identify terminal strips as indicated in this Article, above. Identification devices shall be self-stick, plastic tape strips with permanent, machine-printed numbers. Hand-written labels are not acceptable.
- f. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.
- g. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., DC signal and AC power).
- h. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.
- i. Provide a single copper bus bar with 5/16-inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.
- j. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
- k. When DC power or low voltage AC power is required, furnish and install in the panel required power supplies and transformers.
- l. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.

2.03 PROCESS TAPS, SENSING LINES, AND ACCESSORIES

A. Pressure Sensing Lines and Accessories for Flow/Pressure Transmitters:

- 1. Material: Type 316 stainless steel tubing, ASTM A 269, medium wall thickness.
- 2. Pressure Rating: same as connecting pipe.
- 3. Size: 3/8-inch O.D.
- 4. Connections: Type 316 stainless steel compression type, "Swagelok" by Crawford, or equal.
- 5. Shut-off Valves:
 - a. Type: Ball.
 - b. Pressure Rating: same as connecting line.
 - c. Body, Ball and Stem: Type 316 stainless steel.
 - d. Packing: High density TFE.
 - e. Handle: Nylon with metal travel stops.

- f. Support Rings: TFE coated Type 316 stainless steel.
 - g. End Connections: Removable.
 - h. Products and Manufacturers: Provide products of one of the following:
 - 1) Whitey valves as manufactured by the Swagelok Company,
 - 2) Or equal.
6. Manifolds:
- a. Type: See data sheets.
 - b. Materials: See data sheets.
 - c. Products and Manufacturers: Provide products of one of the following:
 - 1) Anderson-Greenwood,
 - 2) Swagelok,
 - 3) Or equal.
- B. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches:
- 1. Existing Pressure Taps for sensing lines and accessories to be verified and used.
 - 2. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems:
 - a. Material and Fittings: Type 304 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403).
 - b. Sizes: 1/2-inch minimum for main sensing piping and 1/4-inch gauge and switch connections.
 - c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Exposed Piping Schedule in Section 15052, Exposed Piping Installation.
 - d. Accessories:
 - 1) For applications not requiring diaphragm seals, provide separate 1/2-inch Type 316 stainless steel threaded ball valve for each gauge and switch.
 - 2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff.

2.04 DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

A. General:

1. Primary sensors and field instruments shall conform to the requirements of the Instrument Data Sheets provided after PART 3 of these specifications.

2.05 PANEL INSTRUMENTS AND DEVICES

- ### A. General: Do not fabricate, ship, or assemble instruments and devices in panels until required Shop Drawings and other submittals required for fabrication are approved or accepted as required.

B. Selector Switches, Pushbuttons, and Indicating Lights

1. General:

- a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
- b. Type: Heavy duty, oil tight.
- c. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
- d. Mounting: Flush mounted on control panel front, unless otherwise noted.
- e. NEMA rated to match panel in which mounted.

2. Pushbuttons (Standard or Illuminated):

- a. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
- b. Contacts: Comply with the requirements specified for selector switches.

3. Indicating Lights:

- a. Type: Light-Emitting Diode (LED).
- b. Lamps: 2.2-volt, long life (20,000 hours minimum).

4. Button and Lens Colors:

- a. Red for indication of open, on, or running.
- b. Green for indication of closed, off (ready), or stopped.
- c. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
- d. White for indication of electrical control power on.
- e. Blue for indication of remote.

5. Products and Manufacturers: Provide one of the following:

- a. Eaton Corp.
- b. Allen Bradley.
- c. Or Equal.

C. 120VAC Main and Branch Circuit Breaker

1. General:

- a. Circuit breakers shall be furnished and installed in control panels to provide automatically operated switch protection in an electrical circuit from damage caused by an overload or short circuit.
- b. Branch circuit breakers shall be approved for branch circuit applications in the United States.

2. Features:

- a. Type: High Density Circuit Breaker.
- b. Provide Single Pole 120/240V breakers within the control panels.
- c. Rating: Provide breakers with proper amp rating to protect the circuit it serves. Normal operating load of each circuit shall be noted on the panel power distribution wiring drawing.
- d. Insulation Resistance: 100M-ohm at 500VDC.
- e. Terminal Type: Tubular screw with self-lifting box lug.
- f. Push-to-set mechanism for circuit actuation.
- g. Manual trip button.
- h. DIN rail mounted.
- i. Status on/off indicator lights.
- j. Compliance: UL 1077 Listed, CSA C22.2 No. 235, EN/IEC 60934

3. Products and Manufacturers: Provide one of the following:

- a. Allen Bradley.
- b. Or Equal.

D. Control Relay

- 1. Type: General purpose, plug-in type rated for continuous duty.
- 2. Construction Features:
 - a. Coil Voltages: 24 VDC or 120 VAC, as required.
 - b. Contacts:

- 1) Silver cadmium oxide rated not less than 5 A resistive at 120 VAC or 24 VDC continuous.
 - 2) For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.
 - c. Relays to have clear plastic dust cover.
 - d. Relays to have pilot light to show energized coil.
 - e. Relays to be UL recognized.
 3. Products and Manufacturers: Provide one of the following:
 - a. Schneider Electric, Square D Company
 - b. Dayton
 - c. Or Equal.
- E. Time Delay Relay
1. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break, or interval operation.
 2. Construction Features:
 - a. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break, or interval operation.
 - b. Construction Features:
 - 1) MOS digital circuit with transformer coupled power.
 - 2) Switch selectable ranges for 1 second, 10 seconds, 1 minute, 10 minutes, 1 hour, and 10 hours.
 - c. Minimum Setting: Three percent of range, except 50 milliseconds for one-second range.
 - d. Setting Knob Accuracy: 10%
 - e. Contacts: SPDT rated for 5A at 24 VDC.
 - f. Housing: Plug-in design with dust and moisture resistant molded plastic case.
 - g. Power Input: 24 VDC
 - h. Operating Temperature: 0°C to 55°C.
 - i. The unit shall have an LED to show timing status.
 - j. Relays to be UL recognized.

3. Products and Manufacturers: Provide one of the following:
 - a. Allen Bradley
 - b. Schneider Electric
 - c. Eaton
 - d. Or Equal

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Environmental Requirements:

1. No instrument shall be scheduled to be installed in an area where active construction can cause it to be damaged unless CONTRACTOR provides adequate protection for said instrument.

B. Installation of Instrumentation:

1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
2. Locate sensors where shown on the Drawings. Confirm exact locations in the field with ENGINEER.
3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.

C. Services and Operator Instructions:

1. CONTRACTOR shall furnish all repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory-trained servicemen.
2. CONTRACTOR shall furnish, as part of this Contract, a one-year service contract covering parts and labor for the instruments furnished. Service contract shall be with nearest "Authorized dealer/service representative" for on-Site service.
3. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the OWNER.

3.03 FIELD QUALITY CONTROL TESTS

- A. Field verify the calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.
 - 1. For each calibration certification sheet, include the following information:
 - a. Project name.
 - b. Tag number and description.
 - c. Manufacturer.
 - d. Model and serial number.
 - e. Date, time and person who performed calibration.
 - f. Calibration data to include.
 - 1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
 - 2) Switch setting, contact action and deadband, if applicable, for discrete elements.
 - g. Space for comments.
 - h. Signature and date.
 - 2. System Check-Out and Start-Up Responsibilities:
 - a. Check and approve the installation of instrumentation system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
 - b. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, and checking operation functions. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.
 - c. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.
 - d. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.
 - e. CONTRACTOR shall furnish ENGINEER an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the System Supplier.

3.04 SUPPLEMENTS

- A. The Data Sheets following the "End of Section" designation are part of this Specification section. The table below lists all data sheets by article number and is provided for references purposes only.

Article	Description	Page
3.3.A.1	Differential Pressure Switch	17
3.3.A.2	Pressure Switch	18
3.3.A.3	Pressure Indicating Transmitter	19

END OF SECTION 13400

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT	Differential Pressure Switch		SHEET 1 OF 1
PROJECT	POPES HEAD PUMPING STATION		SPEC. NO. 13420 - 3.3.B.1
TAG NO.			
Ref. Dwg. No.:	1	DPS - 6301 / 6302 / 6303	
		I - 02	
PROCESS			
Location:	2	Pump Discharge	
Service:	3	Pump Discharge Valve	
Vessel / Line No.:	4	Pump Discharge	
Fluid:	5	Potable Water	
Temp. Min/Max:	6	TBD	
Press. Min/Max:	7	TBD	
PERFORMANCE			
Range:	8	TBD	
Temperature:	9	-20 to 140 degrees F.	
Repeatability:	10	±1% of span.	
Deadband:	11	±1% of span.	
SENSOR			
Type:	12	Differential Pressure Sensor.	
Element:	13	Slack diaphragm type.	
Diaphragm Seal:	14	NA; (See Notes, Line 31).	
Mounting:	15	Integral Mount with Switch.	
Additional Features:	16		
SWITCH			
Type:	17	Differential Pressure Switch.	
Power Supply:	18	120 VAC.	
Relays:	19	SPDT.	
Rating:	20	5 A at 120 VAC.	
Switch Action:	21	NO contact	
Setpoints:	22	TBD	
Enclosure/Housing:	23	NEMA 4X; Covered terminal strip; Body shall be capable of sustaining 100% pressure reversal throughout its range.	
Mounting:	24	Pressure Connection Mount	
Connections:	25	Process Conn.: 1/2 inch NPT.	
Area Classification:	26	Not Applicable	
Additional Features:	27		
NOTES			
General:	28	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.	
Function:	29	The differential pressure switch shall be capable of sensing pressure from two sources and, when their differences reach a preset value, close or open sets of unpowered contacts.	
Installation:	30	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.	
Diaphragm Seal:	31	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Diaphragm Seal shall be capable of sustaining 100% pressure reversal throughout its range. Refer to Diaphragm Seal Data Sheet for requirements.	
	32		
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MANUFACTURE			
Manufacturer:	38	Provide products of one of the following, Or Equal:	
		United Electric Controls	Ashcroft

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT	Pressure Switch			SHEET	1	OF	1
PROJECT	POPES HEAD PUMPING STATION			SPEC. NO. 13420 - 3.3.B.2	ADDENDUM/C.O.		
TAG NO.		PS - 3111	PS - 6111				
Ref. Dwg. No.:	1	I - 02	I - 02				
PROCESS							
Location:	2	Pump Suction	Pump Discharge Header				
Service:	3	Potable Water Pumps	Potable Water Pumps				
Vessel / Line No.:	4	Common Header	Pump Station Discharge Header				
Fluid:	5	Potable Water	Potable Water				
Temp. Min/Max:	6	TBD	TBD				
Press. Min/Max:	7	TBD	TBD				
Velocity Min/Max:	8	TBD	TBD				
PERFORMANCE							
Range:	9	TBD	TBD				
Temperature:	10	-20 to 140 degrees F.	-20 to 140 degrees F.				
Repeatability:	11	±1% of range.	±1% of range.				
Deadband:	12	Adjustable;	Adjustable;				
SENSOR							
Type:	13	Diaphragm/Piston Pressure Sensor.	Diaphragm/Piston Pressure Sensor.				
Element:	14	Transducer.	Transducer.				
Diaphragm Seal:	15	(See Notes, Line 35).	(See Notes, Line 35).				
Capillary Tubing:	16	316 S.S. Capillary to extend from process connection to switch.	316 S.S. Capillary to extend from process connection to switch.				
Mounting:	17	Integral Mount to Switch.	Integral Mount to Switch.				
Area Classification:	18	Not Applicable	Not Applicable				
Additional Features:	19						
SWITCH							
Type:	20	Snap Action Switch. SPDT	Snap Action Switch. SPDT				
Power Supply:	21	120 VAC	120 VAC				
Relays:	22	SPDT, snap action.	SPDT, snap action.				
Rating:	23	Not less than 10A at 120 VAC; 0.5A at 125 VDC.	Not less than 10A at 120 VAC; 0.5A at 125 VDC.				
Switch Action:	24	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.				
Setpoints:	25	TBD	TBD				
Enclosure/Housing:	26	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.				
Mounting:	27	Pipe Stand Mount; External Mounting Lugs; 316 S.S. Hardware.	Pipe Stand Mount; External Mounting Lugs; 316 S.S. Hardware.				
Connections:	28	Process Conn.: 1/4 inch NPT; Electrical Conn.: 3/4 inch NPT.	Process Conn.: 1/4 inch NPT; Electrical Conn.: 3/4 inch NPT.				
Area Classification:	29	Not Applicable	Not Applicable				
Additional Features:	30	Set/Reset Point Adjustment (See Notes, Line 34).	Set/Reset Point Adjustment (See Notes, Line 34).				
NOTES							
General:	31	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.					
Function:	32	Pressure Switch shall sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.					
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.					
Set/Reset Point:	34	Provide Set and Reset Point adjustable external adjusting nuts and pressure setting scales in psi. Provide metal cover with gasket for adjusting nuts.					
Diaphragm Seal:	35	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.					
	36						
	37						
	38						
	39						
MANUFACTURE		Provide products of one of the following, Or Equal:					
Manufacturer:	40	Automatic Switch Company (ASCO)	Ashcroft	United Electric			

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT	Pressure Transmitter		SHEET 1 OF 1
PROJECT	POPES HEAD PUMPING STATION		SPEC. NO. 13420 - 3.3.B.3 ADDENDUM/C.O.
TAG NO.		PIT - 3101	PIT - 6101
Ref. Dwg. No.:	1	I-02	I-02
PROCESS			
Location:	2	Pump Suction	Pump Discharge
Service:	3	Water Pumps	Water Pumps
Vessel / Line No.:	4	Common Header	Pump Station Discharge Header
Fluid:	5	Water	Water
Temp. Min/Max:	6	30 to 120 °F	30 to 120 °F
Press. Min/Max:	7	TBD	TBD
PERFORMANCE			
Range:	8	TBD	TBD
Accuracy:	9	±0.1% of calibrated span (includes effects of linearity, hysteresis, and repeatability).	±0.1% of calibrated span (includes effects of linearity, hysteresis, and repeatability).
Temperature:	10	-20 to 180 °F; (See Notes, Line 35).	-20 to 180 °F; (See Notes, Line 35).
Repeatability:	11	±0.05% of calibrated span.	±0.05% of calibrated span.
Damping:	12	Internal Adjustment.	Internal Adjustment.
Hysteresis:	13	±0.05% of calibrated span.	±0.05% of calibrated span.
Stability:	14	Less than ±0.25% of Transmitter upper range limit (drift over 6 month period).	Less than ±0.25% of Transmitter upper range limit (drift over 6 month period).
Ovrange Protec.:	15	Positive overrange protection: At least 1.25 times maximum span limit.	Positive overrange protection: At least 1.25 times maximum span limit.
SENSOR			
Type:	16	Gauge Pressure	Gauge Pressure
Element:	17	Transducer.	Transducer.
Diaphragm Seal:	18	(See Notes, Line 40).	(See Notes, Line 40).
Capillary Tubing:	19	316 S.S	316 S.S
Mounting:	20	Integral Mount to Transmitter.	Integral Mount to Transmitter.
Area Classification:	21	Not Applicable	Not Applicable
Additional Features:	22		
TRANSMITTER			
Type:	23	Solid state, 2-wire, Differential Capacitance or Resonant Wire Type Transmitter.	Solid state, 2-wire, Differential Capacitance or Resonant Wire Type Transmitter.
Output:	24	4-20 mA DC; (See Notes, Line 36).	4-20 mA DC; (See Notes, Line 36).
Power Supply:	25	24 VDC; Operates on power from receiver or remote power supply.	24 VDC; Operates on power from receiver or remote power supply.
Indication / Display:	26	Integral LCD Indication for Pressure in Engineering Units.	Integral LCD Indication for Pressure in Engineering Units.
Enclosure/Housing:	27	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing; Covers threaded and seated on O-rings.	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing; Covers threaded and seated on O-rings.
Mounting:	28	Pipe Stand Mount.	Pipe Stand Mount.
Connections:	29	Process Conn. 1/2 inch NPT; Electrical Conn.: 1/2 inch NPT.	Process Conn. 1/2 inch NPT; Electrical Conn.: 1/2 inch NPT.
Area Classification:	30	Not Applicable	Not Applicable
Additional Features:	31	Built-In Surge and RFI protection.	Built-In Surge and RFI protection.
NOTES			
General:	32	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.	
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.	
Calibration:	34	Zero and Span (coarse & fine) adjustments in electronics compartment. Provide Zero Elevation and Suppression so that the extent of suppression plus the calibration span does not exceed the upper range limits of the sensor.	
Amb. Temp. Effect:	35	Total Error per 100 deg. F change between Ambient Temperature Limits: < ±1.0% transmitter range limit (max. span).	
Output:	36	Digital process variable signal superimposed on 4-20 mA DC signal without compromising loop integrity.	
Shutoff Valve:	37	Provide a single shutoff valve at each process line tap to enable live process removal of transmitter. Provide Type 316 S.S. 3-valve manifold for shutoff and pressure equalization on differential pressure and flow measurement applications.	
Calibration Valve:	38	For each unit, provide an additional calibration valve port.	
Hand-held Unit:	39	Provide a hand held interface with keyboard and LED display for easy configuration and testing of transmitter.	
Diaphragm Seal:	40	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.	
	41		
MANUFACTURE			
Manufacturer:	42	Provide products of one of the following, Or Equal:	
		Rosemount - Division of Emerson	ABB Siemens

NO TEXT ON THIS PAGE

SECTION 15010
VALVE ACTUATOR

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install electric valve actuator and appurtenances, complete and operational.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.
3. Section 09900, Painting.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. American Bearing Manufacturers Association (ABMA).
2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
3. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
4. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
5. ASTM A276, Specification for Stainless Steel Bars and Shapes.
6. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
7. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
8. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
9. ASTM A536, Specification for Ductile Iron Castings.
10. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
11. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
12. NEMA MG 1, Motors and Generators

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer.
2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of actuator Supplier is furnishing.
3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the Contractor.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Power and control wiring diagrams, including terminals numbers for electric-motor actuators. Control wiring diagram shall identify project specific connections.
 - b. Calculations for sizing of electric actuators.
 - c. Calculations for sizing of operating mechanism with extension stems.
 - d. Calculations for sizing of gear actuators.
2. Product Data:
 - a. Product data sheets.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by Engineer.
2. Manufacturer Instructions:
 - a. Submit manufacturer's instructions for handling, storing, and installing actuators and appurtenances. Provide templates and setting drawings for actuators and appurtenances that require anchor bolts or similar anchorages.
3. Source Quality Control Submittals:

- a. Submit copies of shop test results and inspection data, certified by manufacturer.
 - 4. Field Quality Control Submittals:
 - a. Submit results of field tests required.
 - 5. Supplier's Reports:
 - a. When requested by Engineer, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
 - 6. Qualifications Statements:
 - a. When requested by Engineer, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.
 - C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Furnish operation and maintenance manuals in accordance with Section 01782, Operations and Maintenance Data.
 - b. Furnish in operations and maintenance manuals complete nameplate data for electric actuator.
 - D. Maintenance Material Submittals: Submit the following:
 - 1. Spare Parts, Extra Stock Materials, and Tools:
 - a. Spare Parts and Extra Stock Materials: Furnish as specified for actuator.
- 1.05 DELIVERY, STORAGE AND HANDLING
- A. Packing, Shipping, Handling, and Unloading:
 - 1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 - 2. Inspect boxes, crates, and packages upon delivery to Site and notify Engineer in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
 - B. Storage and Protection:
 - 1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 - 2. Conform to Section 01600, Materials and Equipment.

PART 2 – PRODUCTS

2.01 ELECTRIC ACTUATORS (OPEN/CLOSE)

- A. Manufacturers: Provide products of one of the following:
 - 1. Limitorque QX or MX.
 - 2. No equal.
- B. Application Criteria:
 - 1. Ambient Temperature Rating: -20 to +158 degrees F.
 - 2. Ambient Humidity: 100 percent.
 - 3. Maximum Differential Pressures Across Closed Valve: 200 psi.
 - 4. Maximum Flows Through Full-Open Valve: Refer to Schedule of Valves with Electric Actuators located at end of this Section.
 - 5. Power Supply: 480-volt, three-phase, 60 Hertz.
 - 6. Control Voltage: 120 VAC, single phase, 60 Hertz.
 - 7. Torques: As determined by valve manufacturer.
 - 8. Duty Cycle: Sixty starts per hour, minimum.
- C. General:
 - 1. Conform to AWWA C540 and this Section.
 - 2. Provide actuator operable with handwheel, even after disengaging and removing electric motor.
 - 3. Coordinate sizing of each electric actuator with valve manufacturer.
 - 4. Electric actuators shall be suitable for valve orientation as shown.
- D. Electric Motor:
 - 1. General:
 - a. Provide motors suitable for “open/close” service, with high torque characteristics and minimum 70 degree C temperature rating.
 - 2. Motor Construction:
 - a. Enclosure: NEMA 6.
 - b. Insulation: Class H.
 - c. Provide overload protection.
 - d. Motor per NEMA MG1-12.02 and .03 with leakage of less than 10 mA.

- e. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:

1. Housing: Die-cast aluminum or cast-iron.
2. Close-coupled to electric motor.
3. Input Shaft Gearing: Spur or bevel gear assembly.
4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
6. Lubrication: Grease or oil bath.
7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
8. Input Shaft: Hardened alloy steel.
9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:

1. Provide each actuator with "end of travel" limit switches to allow control of desired end position for each direction of travel.
2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
3. Limit switch gearing shall be appropriately lubricated.
4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.
5. Provide each limit switch with four auxiliary contacts. Two contacts shall close and two contacts shall open at a desired end position for each direction of travel.
6. Provide dry contacts (five-amp, 120 VAC) for limit switches.

G. Torque Switches:

1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.

3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.
4. Provide dry contacts (five-amp, 120 VAC) for remote high torque alarm.

H. Handwheel Operation:

1. Provide actuator with handwheel for manual operation, so connected that operation by motor will not cause handwheel to rotate.
2. Should electric power be returned to motor while handwheel is in use, unit shall prevent transmission of motor torque to handwheel.
3. Handwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
4. Handwheel shall have an arrow and the word "OPEN" or "CLOSE" indicating required rotation. Handwheel shall operate in clockwise direction to close.

I. Controls:

1. Provide the following controls in separate compartment integral with actuator.
2. Enclosure: NEMA 6.
3. Starter: Combination reversing magnetic starter with circuit breaker and disconnect switch.
4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled.
6. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
7. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
8. Provide thermal overload and single-phasing protection of motor.
9. Provide set of dry contacts to remotely indicate that actuator is available for remote operation. Provide dry contacts (five-amp, 120 VAC) for remote operation indication.
10. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
11. Provide electrical interlocks as shown.
12. Provide 120 VAC space heater to maintain internal housing temperature at 20 degrees C or other means to prevent condensation in housing.

13. A two-speed timer that permits the motor to be pulsed to achieve a longer stroking time shall be included.

J. Testing:

1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which materials and equipment are to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Install actuators and appurtenances in accordance with:
 - a. Supplier's instructions and the Contract Documents.
 - b. Requirements of applicable AWWA standards.

B. Valve Actuator:

1. Operators:
 - a. Avoid placing operators at angles to floors or walls.
 - b. Orient motor actuator to allow convenient access to pushbuttons and handwheel.

3.03 FIELD QUALITY CONTROL

A. Field Tests:

1. Adjust all parts and components as required to provide correct operation of valves.
2. Conduct functional field test on valve in presence of Engineer to demonstrate that each valve operates correctly.
3. Verify satisfactory operation and controls of motor operated valves.
4. Demonstrate satisfactory opening and closing of valve at specified criteria requiring not more than 40 pounds effort on manual actuators.
5. Test valve type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

B. Supplier's Services:

1. Provide services of qualified factory-trained service technicians to check and approve installation of actuator.

2. Supplier's serviceman shall perform the following:
 - a. Instruct Contractor in installing equipment.
 - b. Supervise installation of equipment.
 - c. Inspect and adjust equipment after installation and ensure proper operation.
 - d. Instruct Owner's personnel in operating and maintaining the equipment.
3. Manufacturer's representative shall make a minimum of (4) visits, with a minimum of (8) hours onsite for each visit. First visit shall be for instruction of Contractor in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
4. Training: Furnish services of Supplier's qualified factory trained specialists to instruct Owner's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01800, Equipment and System Training.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.04 SUPPLEMENTS

- A. The supplements listed below, following "End of Section" designation, are a part of this Specification Section:
 1. Table 15010-A, Schedule of Valves with Electric Actuators.

END OF SECTION 15010

TABLE 15010-A, SCHEDULE OF VALVES WITH ELECTRIC ACTUATORS

Location	Type	Service	Line Size (in)	Valve Size (in)	Operator (Man., Elec., Pneu.)	Maximum Normal Flow Through Valve (gpm or mgd)	Actuator (O/C or Mod.)	Open/Close Valve Travel Time (sec.)	Control Station Location
Pump 3	Ball Valve	Potable Water	24	24	Electric	11,805 gpm/17 mgd	Open/Close	180	Local

NO TEXT ON THIS PAGE

SECTION 16050

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
2. Temporary Utilities: CONTRACTOR shall provide temporary power and lighting in accordance with Section 01500, Construction Facilities and Temporary Controls.
3. Demolition: Electrical demolition shall be in accordance with Section 02220, Demolition. Demolition shall include the removal of all conduit and wiring associated with the demolished electrical equipment. Equipment pads supporting demolished electrical equipment shall be removed and the floor repaired. Demolished conduits shall be cut flush with floor and sealed to prevent moisture from entering the proposed enclosures that may be installed above.
4. The scope of work for this project primarily includes, but is not limited to, the following:
 - a. Installation of a new 12.47:4.16 kVAC transformer inside pump station screen wall.
 - b. Installation of a new 480:4160 VAC step-up transformer inside pump station screen wall.
 - c. Installation of a new 4160:480 VAC transformer inside pump station screen wall.
 - d. Installation of a generator docking station.
 - e. Installation of new 4160 VAC switchgear with automatic transfer switch controller.
 - f. Coordination of outages with OWNER and NOVEC for installation of new transformers and switchgear.
 - g. Installation of three medium voltage Reduced Voltage Soft Starters (RVSSs) including power and control wiring.
 - h. Replacement of existing 480 VAC motor control center with integral lighting panel including the replacement of all existing power and controls wiring.
 - i. Underground conduits and duct banks outside of pump station to support new equipment.
 - j. Replacement of 12.47 kVAC cable from the utility's service point on Popes Head Road to the proposed 12.47:4.16 kVAC transformer.
 - k. Demolition of existing 4160 VAC switchgear, 2300 VAC switchgear, 480 VAC control center, 12.47:4.16 kVAC transformer, 12.47:2.3 kVAC transformer, 2300:480 VAC transformer, 2300 VAC motor starters, abandoned supervisory control panel and 4160 VAC soft starter.
 - l. Installation of temporary power to PLC panel.

B. Coordination:

1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
2. Coordination and Intent of Electrical Drawings:
 - a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment. CONTRACTOR shall provide equipment that fits in allocated space or provide alternative power plan for approval by ENGINEER.
 - b. Drawings show the principal elements of the electrical Work and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
 - c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.
 - d. Drawings are provided for CONTRACTOR 's guidance in fulfilling the intent of the Contract Documents CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.
3. Obtain from OWNER record drawings required to execute the Work.
4. Field Coordination:
 - a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
 - b. Coordinate the interface of equipment with OWNER's personnel and field conditions.
 - c. Field-compare existing starter and panel control circuit terminations from record documents with existing circuits.
 - d. Field-trace existing circuits as required to interface the equipment provided.
 - e. Field-identify terminations for starters and panel controls for follow function for re-connection.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 02220, Demolition.
3. Section 02316, Earthwork.
4. Section 03005, Concrete.
5. Section 05051, Anchor Systems.

6. Section 09900, Painting.
7. Section 13400, Instrumentation and Controls

D. Area Classifications:

1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
2. Wet Locations: Comply with NEC and NEMA requirements for wet locations. Enclosures in wet locations shall comply with NEMA 4 unless specified otherwise. Enclosures shall be fabricated from stainless steel.
3. Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise. Enclosures shall be fabricated from stainless steel.
4. Hazardous Locations: Comply with NEC requirements for the Class and Division designated.
5. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.
6. Outdoor areas shall be considered wet locations.

1.02 QUALITY ASSURANCE

A. Qualifications:

1. Electrical subcontractor:
 - a. Electrical subcontractor shall have not less than five years' experience installing electrical systems of the types required for the Project.
 - b. Electrical subcontractor shall possess a valid electricians' and CONTRACTOR s' license in the jurisdiction where the Site is located.
 - c. Submit the following information for not less than three successful, completed projects: project name and location; year completed; name and contact information for: prime CONTRACTOR for whom electrical subcontractor worked, project OWNER, and project ENGINEER or architect, including addresses and telephone numbers.
2. Wiring Coordinator:
 - a. Retain services of a wiring coordinator who shall prepare complete point-to-point interconnection wiring diagrams. Diagrams shall identify all external interconnecting wiring associated with new or modified existing equipment.
 - b. Qualifications: Wiring coordinator shall be experienced in developing diagrams of the type required and shall have served in a similar wiring coordinator role on a completed project of similar size and complexity to the Project.
 - 1) Submit qualifications and approach for the Project not later than the pre-submittal conference required in Section 01330, Submittals.

2) Submit to ENGINEER the items indicated below not less than three weeks prior to the pre-submittal conference required in Section 01330, Submittals

- a) List of projects where the wiring coordinator developed point-to-point wiring diagrams.
- b) Samples of diagrams developed for the listed projects.
- c) Example wiring diagram proposed for the Project with a preliminary list of drawings to be produced.
- d) Plan of how information will be obtained and documented.

c. Responsibilities:

- 1) Develop diagrams for performing the Work and to document terminations. Prepare diagrams in accordance with this Section and the example wiring diagram accepted by ENGINEER. Diagrams are in addition to loop diagrams required in Section 13400, Instrumentation and Controls.
- 2) Use information obtained from approved Shop Drawings and approved CONTRACTOR's other submittals, record drawings, and field inspections as required to complete the diagrams.
- 3) Attend pre-submittal conference required under Section 01330, Submittals, and periodic coordination and progress meetings required in Section 01310, Project Meetings.

B. Component Supply and Compatibility:

- 1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

C. Regulatory Requirements:

- 1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.
- 2. Codes: Refer to Section 01410, Regulatory Requirements, for indication of applicable codes.

1.03 SUBMITTALS

A. General:

- 1. Provide submittals per Section 01330 Submittals.
- 2. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section. Do not furnish partial submittals.
- 3. Shop Drawings and other CONTRACTOR submittals shall be submitted in Adobe PDF format and shall be searchable. Drawings included as part of the submittal shall also be searchable.
- 4. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
- b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
- c. List of components including manufacturer's name and catalog number (or part number) for each.
- d. Point-to point interconnection wiring diagrams.

2. Product Data:

- a. Manufacturer's name and product designation or catalog number.
- b. Electrical ratings.
- c. Manufacturer's technical data and specifications.
- d. Manufacturer's indication of compliance with applicable reference standards.
- e. Painting and coating systems proposed.

3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing, field quality control testing, and operational acceptance testing.

C. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:

- a. Installation data and instructions.
- b. Instructions for handling, starting-up, and troubleshooting.

2. Source Quality Control Submittals: Results for required shop testing.

3. Startup Plan: Startup plan as described in Article 3.07 of this Section.

4. Field Quality Control Submittals: Results for required field testing.

5. Operational Acceptance Testing Submittals: Results for required operational acceptance testing.

6. Qualifications:

- a. Electrical subcontractor.
- b. Wiring coordinator, including information required of wiring coordinator in Paragraph 1.2.A of this Section.

D. Closeout Submittals: Submit the following:

1. Provide as-built documents per Section 01780, Project Record Documents.

2. Record Documentation:

a. System Record Drawings: Include the following:

- 1) One-line wiring diagram of the electrical distribution system.
- 2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
- 3) Layouts of the power and lighting arrangements and the grounding system.
- 4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.
- 5) Supplier submittal drawings and those included as part of operation and maintenance manuals updated to include all changes after manufacture.

b. Point-to-Point Interconnection Wiring Diagram Drawings: Include the following:

- 1) External wiring for each piece of equipment, panel, instrument, and other devices and wiring to control stations, lighting panels, and motor controllers.
- 2) Numbered terminal block identification for each wire termination.
- 3) Identification of the assigned wire numbers for all interconnections.
- 4) Identification of wiring by the conduit tag in which the wire is installed.
- 5) Terminal, junction, and pull boxes through which wiring is routed.
- 6) Identification of equipment and the submittal transmittal number for equipment from which wiring requirements and termination information was obtained.

c. Record documents shall indicate final equipment and field installation information.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Product delivery, storage and handling shall be per Section 01600, Materials and Equipment.

PART 2 – PRODUCTS

A. Performance Criteria:

1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of 14 degrees F to 94 degrees F and an elevation of 400 feet above mean sea level.
2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.

B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies and approved by the Authority Having Jurisdiction.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. General:

1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

B. Staging, Sequencing, and Coordination with Existing Facilities:

1. Schedule, sequence, and install materials and equipment in accordance with Section 01140, Limitations on Sequence of Construction.
2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by OWNER.
3. When operation of existing facilities and Site is disrupted due to CONTRACTOR 's operations, comply with Section 01140, Limitations on Sequence of Construction, unless otherwise allowed by OWNER.
4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.
5. Interruptions of existing circuits, not addressed in Section 01140, Limitations on Sequence of Construction, shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.03 FIELD QUALITY CONTROL

A. Field Quality Control – General:

1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:

1. Prior to requesting certificate of Beneficial Use, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required.

2. Perform the following operational tests on electrical systems:
 - a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.
 - b. Remove and re-apply power supply to automatic transfer equipment to verify operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.
 - c. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
 - d. Operate lighting systems and receptacle devices to verify proper operation and connections.
3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.
4. Prepare and submit report on the operational acceptance testing tests. Report shall include complete information on the operating conditions and durations.

C. Manufacturer's Services:

1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

3.04 COMMISSIONING AND STARTUP

- A. The CONTRACTOR shall be responsible for and furnish all labor, materials, instruments, incidentals, and equipment required for startup, testing, and commissioning. Temporary facilities required to carry out the specified testing, including temporary pipe, pumps, and other appurtenances, shall be furnished and installed, and removed when no longer required for startup, testing, and commissioning.
- B. Startup and testing shall be conducted during normal working hours during the workweek of Monday through Friday, unless otherwise approved by the OWNER. Where continuous long-term testing is required, testing may continue over the weekends and holidays with prior approval from the OWNER.
- C. CONTRACTOR shall coordinate all the commissioning, startup and testing services for the following:
 - New Transformer No. 1, Transformer No. 2, TX-3, and TX-4.
 - New generator docking station.
 - New switchgear SWGR-1.
 - Emergency operation of SWGR-1 and pump station on generator power using 375 kW and 1000 kW gensets.
 - Rebuilt pump motor 1 and associated new RVSS.
 - Rebuilt pump motor 2 and associated new RVSS.
 - Existing pump motor 3 and associated new RVSS.
 - New motor control center MCC-1 power distribution and control logic.
 - New pressure switch relay box.
 - Integral RVSS controls including but not limited to motor and pump condition monitoring, emergency stops, pressure sensing, and valve control and feedback.

1. Constraints
 - a. Startup and testing shall be conducted in a manner that does not compromise the existing facilities. Any startup and testing activities affecting operation of the existing facilities shall be coordinated with the OWNER and shall be shown on the Progress Schedule. The OWNER will cooperate with the CONTRACTOR to the extent possible but will have sole authority in decisions affecting existing operations.
2. Startup Manager, Startup Team, and Manufacturer's Field Service Representatives
 - a. The CONTRACTOR shall maintain a dedicated startup team led by a startup manager. The individual to be designated as startup manager shall be identified within 45 days of the Notice to Proceed and will be reviewed by OWNER and ENGINEER. Once accepted, the CONTRACTOR shall not change the startup manager throughout the full period of performance of the Work without written permission of the OWNER. Once engaged in the Project, the startup manager shall attend regular construction progress meetings. No startup activities shall begin until the startup manager has arrived at the jobsite.
 - b. The startup manager shall be on Site full time at least 30 days prior to any field startup and testing activities and shall remain on site until all startup, testing, and commissioning activities are complete.
3. Startup Manager
 - a. The startup manager shall be a startup and testing expert with a minimum of 5 years of experience starting up equipment and systems of similar type, size, capacity, and complexity to the equipment and systems included in this Project. The startup manager shall have the necessary experience to fully understand all startup requirements, to manage the CONTRACTOR's resources providing the startup services, and to prepare all startup documentation, as specified. The startup manager's assigned duties and responsibilities are those specifically related to planning, supervising, and executing startup activities and shall include, but shall not be limited to the following:
 - 1) Coordinating all testing and startup activities.
 - 2) Preparing all startup and field testing plans, documentation, and forms.
 - 3) Liaising between the manufacturer, supplier, CONTRACTOR, ENGINEER, and OWNER for all startup and testing activities.
 - 4) Developing a comprehensive schedule for all startup activities and providing regular schedule updates. The startup and testing schedule shall be incorporated into the Progress Schedule.
 - 5) Scheduling and leading startup, testing, and commissioning planning meetings.
 - 6) Conducting coordination meetings during startup, testing, and commissioning at least weekly.
 - 7) Coordinating manufacturers' services and their certification of proper installation and/or operation of equipment as required by the Specifications.
 - 8) Overseeing and administering all startup, testing, and commissioning activities, including either direct participation in the activities and/or oversight and monitoring of activities. It shall be the startup manager's responsibility to assure

that all tests have been completed in accordance with accepted testing procedures.

- 9) Ensuring readiness for and coordinating maintenance, repair, and adjustment of equipment and systems during startup testing, and commissioning.
- 10) Conducting or overseeing pre-test checks to ensure readiness for testing.
- 11) Ensuring all testing equipment is in proper working order and has been calibrated to appropriate standards.
- 12) Developing safe work policies and procedures including lockout/tagout procedures and personal protective equipment policies, that will be followed during all field startup and testing activities. At a minimum the CONTRACTOR shall comply with OSHA and the OWNER's established safety guidelines. It shall be the startup manager's responsibility to assure all safety procedures are followed at all times.
- 13) Coordinate all equipment training sessions to assure that the training is compliant with the requirements of the Specifications and includes all applicable operation, maintenance, safety, functional, performance, and startup and testing information.
- 14) Switchgear, RVSS, and MCC training sessions will be coordinated by the CONTRACTOR and the supplier.
- 15) Organizing teams made up of qualified representatives of Suppliers, subcontractors, and others, as appropriate, to efficiently and expeditiously startup and test the equipment and systems installed and constructed under this Contract. The objective of this program shall be to demonstrate to the ENGINEER and OWNER that the structures, systems, and equipment constructed and installed under this Contract meet all performance requirements and the facility is ready for operation as intended. In addition, the testing program shall produce baseline operating conditions for the OWNER to use in a preventive maintenance program.
- 16) Ensuring the development and maintenance of records documenting all startup, testing, and commissioning activity. The records shall be organized by major process system into organized files/binders and turned over to the OWNER prior to applying for final payment. Testing records shall be accessible to the ENGINEER and OWNER at all times to allow monitoring of the progress. The reports shall be computer generated searchable PDF files. Scanned images and photocopies are not acceptable except for field checklists completed by commissioning personnel.
- 17) Ensuring the startup team is equipped and ready to make emergency repairs and adjustments to equipment installed and modified as part of the Project.
- 18) Scheduling and conducting a one day workshop with the OWNER and ENGINEER to resolve submittal review comments to the CONTRACTOR 's startup, testing, and commissioning plan submittal.
- 19) Notifying the ENGINEER and OWNER and all respective equipment manufacturers at least 21 days prior to the date when each equipment system is scheduled for pre-startup activities and checks.
- 20) Organize International Electrical Testing Association (NETA) acceptance testing in accordance with the Section 16080, Commissioning of Electrical Systems.

4. Startup Team

- a. The startup team shall include the startup manager and all staff deemed necessary for successful completion of startup, testing, and commissioning. This will typically include ENGINEERs, major equipment vendors, operators, and representatives from the Instrumentation and Control System Supplier. Additional trade representatives may be included as project requirements dictate.

5. Manufacturer's Field Services Representative

- a. The manufacturers shall provide a technically qualified field-service representative for the installation, startup, and testing of equipment furnished, as specified in the equipment sections. The manufacturer shall submit qualifications and experience records for all key personnel to be involved in startup activities.
- b. The manufacturer's field services representative shall be employed full-time in installation, startup, and testing of similar equipment and facilities and work directly for the manufacturer. The representative shall have conducted startup activities similar to those required herein on at least two other projects of similar complexity. The OWNER or ENGINEER shall have the right to reject the manufacturer's field services representative at any time, for immediate replacement by the manufacturer, if the accepted qualifications are not representative of the actual experience or abilities of the representative, as determined by the OWNER or ENGINEER.
- c. The switchgear, MCC, and RVSS manufacturer field services will be provided by the CONTRACTOR. The CONTRACTOR shall coordinate all field service activities.

6. Submittals

- a. CONTRACTOR shall submit the following information in accordance with the requirements of the Submittals Procedures section.
 - 1) Startup manager's qualifications and past project experience including contact names, addresses and current telephone numbers of OWNER representatives that can be used to verify the accuracy of the information. Submittal shall be made at the preconstruction conference.
 - 2) Manufacturers' field services representative's qualifications and past project experience including contact names, addresses and current telephone numbers that can be used to verify the accuracy of the information. Qualification submittals shall be made 3 weeks before the manufacturer's representative is scheduled to be on Site.
 - 3) Manufacturer's certification of proper installation of all equipment as specified in the equipment sections.
 - 4) Equipment and system startup, testing, and commissioning plans and schedule in accordance with the requirements of this section. Startup manager shall coordinate with subcontractors and include their information in the startup and testing plan.
 - 5) Unless otherwise specified in the equipment sections, preliminary copies of field calibration results. Submittal shall be made prior to the start of each test for associated systems.
 - 6) Daily logs.

7. Startup and Testing Requirements.

a. Startup Checks.

- 1) Prior to field testing of all equipment, the CONTRACTOR shall perform the following:
 - a) Inspect and clean equipment, devices, and connected piping so they are free of foreign material.
 - b) Lubricate equipment in accordance with manufacturer's instructions.
 - c) Turn rotating equipment by hand.
 - d) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - e) Test and commission related electrical system components in accordance with the requirements specified in Section 16080, Commissioning of Electrical Systems.
 - f) Calibrate all instruments associated with the equipment.
 - g) Check for proper rotation, adjustment, alignment, balancing, mechanical and electrical connections, and any other conditions that may damage or impair equipment from functioning properly.
 - h) Inspect and verify proper anchorage.
 - i) Obtain manufacturer's certification of proper installation where specified in the equipment sections.
- 2) All equipment shall be confirmed ready to test by the ENGINEER based on the following:
 - a) Acceptance of CONTRACTOR 's startup and testing plan.
 - b) Notification in writing by the startup manager that each piece of equipment or system is ready for testing.
 - c) Verification by the ENGINEER and OWNER that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.
 - d) Cleanliness of equipment, devices, and connected work.
 - e) Adequate completion of work adjacent to or interfacing with equipment to be tested.
 - f) Confirmation of manufacturer's representative's availability to assist with testing, where specified, and satisfactory fulfillment of all other manufacturers' responsibilities as specified.
 - g) ENGINEER's inspection of all related civil construction, mechanical, and electrical installations.
 - h) Confirmation of completion of acceptable testing of all adjacent piping, duct work and other affected Work.

b. Functional Testing.

- 1) All startup checks shall be completed prior to functional testing. Functional testing shall be in accordance with relevant standards and in accordance with instructions of the manufacturers.
- 2) Ancillary and/or temporary facilities necessary to recycle, control, or discharge water, air, chemical, or gas from facilities being tested, shall be operational.
- 3) Functional testing shall include the functional operation of each piece of equipment. All moving parts of equipment and machinery shall be tested and adjusted so that they move freely and function satisfactorily. Functional testing shall demonstrate correct operation of all hardwired interlocks and controls.
- 4) Functional testing of power actuated valves shall include at least 4 full open-close operations. Testing shall demonstrate the maximum number of operations per hour as recommended by the actuator manufacturer without overheating.
- 5) Once functional testing of individual pieces of equipment is completed, individual systems functional testing shall commence. Individual system functional testing shall include startup of the complete system of mechanical, electrical, and instrumentation and control equipment as a functional process system. The individual system shall include but not be limited to the switchgear, MCC, RVSS, associated pump and motor, and all associated instrumentation and controls equipment. Field inspection prior to startup as specified in the Instrumentation and Control System section, other testing by the Instrumentation and Control System Supplier required to verify readiness for automatic operation of the individual system, shall be completed before commencement of individual system functional testing.
- 6) Individual system functional testing shall include operation in manual and automatic modes, startup operation, and shutdown in normal and emergency modes. Individual systems shall be tested over their entire operating range and for sufficient time to demonstrate the intended functionality of each piece of equipment and the system. If any part of a system shows evidence of unsatisfactory or improper operation during the test period, correction or repairs shall be made and the functional testing shall be repeated until satisfactory results are obtained.
- 7) Functional testing of all process and pumping equipment and drive motors, including auxiliary equipment, shall be in accordance with the appropriate and approved test codes, such as those specified by the American Society of Mechanical ENGINEERS, Hydraulic Institute Standards, and IEEE.
- 8) Qualified personnel from the electrical and mechanical trades responsible for installation of the equipment, shall be available during functional testing involving electrically operated equipment. Where appropriate, a representative of the Instrumentation and Control System Supplier shall also be available.

c. Functional Acceptance Testing.

- 1) Once the CONTRACTOR 's functional testing is complete and associated documentation has been submitted and accepted by the ENGINEER, the CONTRACTOR shall conduct functional acceptance testing of each complete process system, to demonstrate individual systems meet the specified requirements. Acceptance testing shall include the successful demonstration of all operating functions and conditions that are specified for the equipment,

system, and controls. The manufacturer's representative shall be on Site during acceptance testing when specified in the equipment specifications.

- 2) The Functional Acceptance Testing shall include the following submissions prior to commencement:
 - a) Prerequisite checklist, to be acknowledged by the ENGINEER prior to initiating the test, that demonstrates that all testing and other Work required to be completed prior to the test is complete.
 - b) Listing of OWNER's personnel necessary to operate the system and conduct any related monitoring of performance.
 - c) A listing of CONTRACTOR 's personnel designated to supervise and direct the OWNER's operators as required herein.
 - d) Listing of standby personnel, equipment, and materials that will be available if needed during the test period.
 - e) Step-by-step procedures for operation of the facility showing how local and remote control of equipment will be demonstrated.
 - f) Description of all data and other information to be reported in support of the completed test. Include any blank data logs that may be used for recording results.
 - g) Descriptions of all necessary calculations that must be completed to verify the specified results are being achieved, including formulas.
 - h) Blank sign-off form for the test acknowledging the CONTRACTOR 's, ENGINEER's, OWNER's, and the equipment manufacturer's acceptance of the test.
- 3) CONTRACTOR shall provide OWNER and ENGINEER 14 days notice prior to testing of any individual system.
- 4) Individual system acceptance testing shall continue for 7 days without interruption for each system, and all parts shall operate satisfactorily in all respects under a range of conditions to simulate the full operating range of the equipment or system. If there are multiple parallel components or trains, then the testing duration will be 7 days for each individual train.
- 5) If any part of a system shows evidence of unsatisfactory or improper operation during the testing period, correction or repairs shall be made and the test repeated until the test is successfully completed. Testing interrupted by utility power failure will not be required to be repeated, but the test shall be continued upon restoration of utility power and extended to the specified duration at no additional cost to the OWNER.
- 6) During this testing period the CONTRACTOR shall operate all new equipment. All existing equipment shall be operated by the OWNER.

8. Commissioning.

- a. Once startup and testing is complete; documentation of all startup and testing activities shall be submitted for reviewed and accepted by the ENGINEER. After acceptance, commissioning of the constructed facilities shall be conducted by the CONTRACTOR working with the OWNER and ENGINEER. The facility shall be

operated in accordance with the operating permit, laws, and regulations. The CONTRACTOR shall provide mechanics, electricians, and controls technicians during commissioning as required for troubleshooting and repair.

9. PLC Commissioning

- a. OWNER shall be responsible for providing all hardware and software modifications for the new PLCs. Startup manager shall coordinate with the OWNER for all startup, commissioning, and testing activities for the PLC.
- b. Startup manager shall be responsible for providing a schedule to include all the PLC activities completed by the OWNER.

3.05 OPERATION ACCEPTANCE TESTING

- A. At the completion of the Individual System Acceptance Tests and when the overall process has stabilized sufficiently as determined by the ENGINEER, operational acceptance testing of the complete facility constructed or modified under the Contract shall be conducted. Operational acceptance testing shall not be conducted concurrently with other individual system acceptance or performance tests.
- B. The test shall run at least 14 days with the entire facility operating in the intended manner. The test shall demonstrate to the satisfaction of the ENGINEER that the facilities are complete and meet all specified requirements and can be continuously operated for their full intended function. During the testing period, the plant shall operate under all control modes, including manual, remote-manual, and automatic. The Owner's staff shall operate the facility.
- C. Duty and standby equipment shall be alternated so that all equipment is selected for duty operation for a period of at least 2 days during the test. Unless indicated otherwise, if any item malfunctions or a defect is found during the test, the item shall be repaired and the test either extended a duration to be determined by the ENGINEER and OWNER depending on the severity of the malfunction or defect, or restarted at time zero with no credit given for the operating time before the malfunction or the defect was found. Malfunctions or defects meeting both of the following conditions may, at the ENGINEER'S discretion, be considered grounds for not requiring restarting the test at time zero:
 1. Malfunctions that do not cause an interruption to the operation of the facility because standby equipment can be placed into service.
 2. Malfunctions that are corrected within four (4) hours of the time the malfunction is detected. Correction of a malfunction or defect will be considered complete only after the affected equipment is placed back into service and is operating as intended for a continuous period of 24 hours without additional failure.
- D. Emergency equipment shall be tested during the 14 day operational acceptance testing period. The OWNER will supply and operate portable generators rated 375 and 1000 kW for connection to the docking station during these tests. Loads will be adjusted by the OWNER within the limits of the portable generator capacity.
- E. All malfunctions, defects in materials or workmanship, or other flaws, which appear during this test period, shall be immediately corrected by the CONTRACTOR. If spare parts from the specified spare parts inventory are used to make repairs, they shall be replaced immediately and must be replaced prior to application for final payment.
- F. The CONTRACTOR shall supply all oil, grease, lubricants, and ancillary equipment required for operational acceptance testing.

- G. All plant control system coordination issues shall be resolved and data trending requirements shall be functional during this period.
- H. During operational acceptance testing treated water meeting regulatory requirements as determined by the OWNER, will be delivered to the distribution system.

3.06 STARTUP SCHEDULE AND STARTUP AND COMMISSIONING PLANS

- A. Plans and schedules shall be developed to facilitate coordinated and efficient startup, testing, and commissioning of the Project equipment and systems.
- B. The CONTRACTOR shall submit a startup, testing, and commissioning plan and schedule to the ENGINEER no later than 90 calendar days prior to the commencement of startup and testing. A minimum of 21 days shall be allowed for review by ENGINEER and OWNER. The schedule and plan must be accepted a minimum of 30 days prior to commencement of startup and testing. The schedule and plan shall include sections for startup checks, functional testing, functional acceptance testing, commissioning, and operational acceptance testing.
- C. Forms for startup and testing shall include identification of equipment or system, startup/test date, nature of startup/test, startup/test objectives, startup/test prerequisites, startup/test results, instruments employed for the startup/test and signature spaces for the ENGINEER's witness (where applicable) and the CONTRACTOR's startup manager.

3.07 STARTUP SCHEDULE

- A. A startup schedule that provides an overall sequence and duration for all startup, testing and commissioning activities, shall be prepared and maintained. This schedule shall serve as a companion to but shall not be a replacement for the startup plan. The startup schedule described in this section shall be integrated into the overall Construction Progress Schedule and shall be prepared as specified for the Construction Progress Schedule in Section 01320, Construction Schedule. The Startup Schedule shall be updated weekly to during the startup, testing, and commissioning period.

1. Startup Plan

- a. The Startup Plan shall include the following:
 - 1) Introduction with a narrative description of the overall testing and startup program. The description shall include all contractual or regulatory treatment requirements to be demonstrated.
 - 2) A summary of the objectives and approach for startup checks, functional testing, functional acceptance testing, commissioning, and operational acceptance testing.
 - 3) List of the instruments, equipment, and systems that will undergo startup and testing with references to the appropriate PIDs, equipment tags/identification numbers, Specification number and standards for testing procedures.
 - 4) Schedule for startup and field testing for each instrument, piece of equipment (including redundant equipment), and system.
 - 5) Safety and emergency response plan including a list of emergency and non-emergency contacts (email and phone).
 - 6) Organization chart for CONTRACTOR's startup and testing personnel with assigned responsibilities for each.

- 7) Startup and testing record keeping plan.
 - 8) Plan for reuse and disposal of water/wastewater from startup, testing, commissioning including information on any required regulatory permits/approvals.
 - 9) Description of temporary facilities that will be provided.
 - 10) List of chemicals to be provided by the OWNER.
- b. Within 7 to 14 days of initial submittal of the startup plan, the CONTRACTOR shall schedule a workshop with the OWNER and ENGINEER to present the plan. The CONTRACTOR shall submit minutes of the workshop, including action items and a schedule for updating the startup plan, to the ENGINEER within 3 days of the workshop.
 - c. Individual plans for each phase of startup, testing, and commissioning can be assembled as chapters in the startup plan or submitted as individual documents but should be correlated to ensure there is not disagreement between chapters or separate documents.
2. Startup Checks Plan
 - a. The startup checks plan shall be subdivided into plans for each system and major component. Each system/major component plan shall include but not be limited to the following:
 - 1) Identification of information for each component or piece of equipment to be inspected as part of the system. All applicable tag numbers shall be included.
 - 2) Specific activities to be completed on each component, piece of equipment, or system as required to demonstrate proper installation and connection.
 - 3) A tracking checklist of prerequisites for the checks and each step of the checking procedure, including any temporary facilities or utility requirements.
 - 4) Listing of manufacturer's representative(s) to be on site during the check.
 - 5) Sign off forms for the CONTRACTOR's startup manager.
3. Functional Testing and Functional Acceptance Testing Plans
 - a. The functional testing plan shall include procedures and reporting for functional testing. The functional testing plan shall be subdivided into testing plans for each system. Each system test plan shall include but not be limited to the following:
 - 1) A narrative description of the purpose and goals of the test for each component, piece of equipment, or system, which should include all activities (including those required by vendors/suppliers) necessary to verify proper equipment and system functionality.
 - 2) Identification of each component or piece of equipment to be tested as part of the system. All applicable tag numbers shall be included.
 - 3) Schedule and duration for the tests.
 - 4) Prerequisites for each test, including any temporary facilities or utility requirements.

- 5) Pass/fail criteria for the test.
- 6) A checklist for tracking testing progress which includes prerequisites for the test and each step of the testing procedure. The check list shall include specified performance criteria that are to be met.
- 7) A description of test apparatus required to conduct the test.
- 8) Identification of all temporary facilities and chemicals require during startup.
- 9) Listing of manufacturer's representative(s) to be on site during the test.
- 10) Certificates of proper installation from the manufacturer as applicable to the test.
- 11) Step-by-step detailed procedure of the test. The level of detail shall be sufficient for a witness to be able to follow the steps during the test and be confident that the test is being performed as planned. All steps required to proceed through the test in an orderly manner are considered significant and each of these steps shall be included in the procedure.
- 12) Copies of the data recording forms that will be used during the test.
- 13) Calculation methodologies to be used to evaluate the data and/or test criteria for the test.
- 14) Sample computations or analyses for the test with results in the same format as the final report. This item is intended to demonstrate how data collected will be used to generate final results. A sample shall be included for each type of computation required for the test and analysis of results.
- 15) Blank sign-off forms for the test acknowledging the startup manager's, Engineer's, Owner's, and equipment manufacturer's acceptance of the test where applicable.

3.08 REPORTS AND RECORDS

- A. Records of all startup and testing shall be compiled by the CONTRACTOR and submitted to the ENGINEER. Prior to being submitted to the ENGINEER, the startup manager shall certify that the results recorded and the tested systems comply with the Contract requirements. Records shall include all documentation assembled for each piece of equipment or system involved in the startup and testing, including all certifications, forms, and check lists completed during the startup and test, and sign-off forms.
- B. Records of all startup and testing shall be compiled as separate documents for each system tested and shall be submitted within 48 hours of completion of the startup and testing for each system. Testing samples that require analysis periods greater than 48 hours shall be clearly defined in the startup plan but shall not preclude delivery of the balance of the records within the 48 hour timeframe.
- C. The CONTRACTOR shall provide formal reporting and documentation of failures, malfunctions or defects, and repairs made during the startup and/or testing activities. A "System Problem Report" form is included at the end of this section and shall be used by the CONTRACTOR to document problems that arise during these tests and their resolution. Records submitted shall include "System Problem Report" forms completed during testing.

SYSTEM PROBLEM REPORT

Project Name:

Test Name:

Test Number:

Problem Type: Hardware Software Documentation Unknown Other

SYMPTOMS:

Time:

Date:

By:

Description:

Can problem be reproduced at will? Y / N

DIAGNOSIS:

Time:

Date:

By:

Description:

CORRECTION:

Time:

Date:

By:

Description:

FINAL SIGN OFF

Time:

Date:

By:

END OF SECTION 16050

NO TEXT ON THIS PAGE

SECTION 16061

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
3. UL 467, Grounding and Bonding Equipment.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Field Acceptance Testing Firm: Retain services of independent testing firm to perform acceptance field testing of grounding system. Testing firm shall have experience in testing grounding systems and shall be a member company of NETA.

B. Regulatory Requirements

1. National Electrical Code, (NEC).
 - a. NEC Article 250, Grounding and Bonding.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Listing of grounding connector types identifying where each will be used.
 - b. Layouts of each structure's ground grid.
 - c. Test point construction details.
2. Product Data:
 - a. Manufacturer's technical information for grounding materials proposed for use.

3. Testing Plans:
 - a. Ground resistance test procedure.
- B. Informational Submittals: Submit the following:
 1. Field Quality Control Submittals
 - a. Results of ground resistance tests at each test point.
- C. Submittals shall be in accordance with Section 01330, Submittals.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Bare Ground Cable:
 1. Manufacturers: Provide products of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.
 - c. Southwire Cable Company.
 - d. Or approved equal.
 2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.
- B. Ground Rods:
 1. Manufacturers: Provide products of one of the following:
 - a. Copperweld, Bimetallics Division.
 - b. ITT Blackburn Company.
 - c. Or approved equal.
 2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.
- C. Grounding Connectors:
 1. Products and Manufacturers: Provide one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or approved equal.

- b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or approved equal.
 - 2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.
- D. Ground Test Well
- 1. Provide heavy-duty test well suitable for heavy-duty traffic.
 - 2. Manufacturer
 - a. Advanced Lightning Technology/allG Fabrication.
 - b. Or approved equal.
 - 3. Diameter and Material: 12.75-inch outside diameter, Schedule 80 PVC.
 - 4. Depth: Two feet.
 - 5. Cover: Provide test well with cast iron cover marked, "Ground" with cast iron ring to support lid.
- E. Ground system components shall comply with UL 467.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.02 STRUCTURE GROUND SYSTEM

- A. Provide ground grids as shown and indicated on the Drawings.
- B. Provide No. 4/0 bare copper cable around exterior perimeter of structures at not less than 2.5 feet below grade, unless otherwise shown or indicated on the Contract Documents.
- C. For structures with steel columns, provide No. 4/0 ground cable from grid to each column around perimeter of structure. Connect cable to steel with exothermic welds.
- D. Connect grids to continuous underground water pipe system, when practical.
- E. For new structures with concrete foundation or footings, connect structure's reinforcing steel or other concrete-encased electrode to grounding grid.

- F. Provide accessible test points for measuring the ground resistance of each grid.
- G. Weld all buried connections except for test points.

3.03 EQUIPMENT GROUNDING

- A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.
- B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.
- C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.
- D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings.
- E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.
- F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold-down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.
- G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.
- H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.
- I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.04 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER and OWNER will witness the testing.
 - 2. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive when installing additional ground rods to increase their effectiveness.
 - 3. Acceptance Testing:
 - a. Perform acceptance testing of grounding system. Testing shall be performed by testing firm in accordance with ANSI/NETA ATS.
 - b. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall comply with ANSI/NETA ATS.

END OF SECTION 16061

SECTION 16070

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systems.
2. Area Classifications: Materials shall be suitable for the area classification(s) shown or indicated on the Drawings and specified in Section 16050, General Provisions for Electrical Systems.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.
3. Section 16050, General Provisions for Electrical Systems.
4. Section 16131, Rigid Conduits.

1.02 REFERENCES

A. Standards referenced in this section are:

1. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
3. ASTM E84, Test Method for Surface Burning Characteristics of Building Materials

1.03 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Detailed installation drawings showing dimensions and compatibility with proposed layout.
2. Product Data:
 - a. Manufacturer's name, product designation, and catalog number of each material item proposed for use.
 - b. Manufacturer's specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed for use.

- c. Pictorial views and corresponding identifying text of each component proposed for installation.
 - d. Documentation that confirms product compatibility with Laws and Regulations.
- B. Informational Submittals: Submit the following:
 - 1. Certifications:
 - a. Submit certifications required under this Section.
 - 2. Manufacturer's Instructions:
 - a. Manufacturer's installation instructions, including recommended tightening torque values for all nuts and bolts.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. B-Line.
 - 2. Kindorf.
 - 3. Unistrut.
 - 4. Or approved equal.

2.02 MATERIALS

- A. Strut, Fittings, and Accessories:
 - 1. General
 - a. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
 - b. Attachment holes, when required, shall be factory-punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
 - c. Fittings, braces, brackets, hardware, and accessories shall be Type 316 stainless steel.
 - d. Strut nuts shall be spring captured Type 316 stainless steel.
 - e. Square and round washers shall be Type 316 stainless steel.
 - 2. Strut materials shall be suitable for area classifications indicated in Section 16050, General Provisions for Electrical Systems, and shown or indicated on the Drawings.
 - a. Dusty Locations:
 - 1) Strut shall be 12-gage carbon steel, hot-dip galvanized after fabrication, complying with ASTM A123/A123M.

- b. Wet Locations:
 - 1) Strut shall be 12-gage Type 304 or 316 stainless steel.
 - c. Corrosive Locations:
 - 1) Strut shall be 12-gage Type 304 or 316 stainless steel.
- B. Hanger Rods:
 - 1. Material:
 - a. Dusty Locations: All-thread, zinc-coated.
 - b. Wet, Corrosive, or Hazardous Areas: Stainless steel.
 - 2. Size: Not less than 3/8-inch diameter, unless otherwise shown on the Drawings or specified.
- C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:
 - 1. Beam clamps shall be stainless steel equipped with stainless steel square-head set screw, and shall include threaded hole sized for attaching the all-thread rod or threaded bolt.
- D. Miscellaneous Hardware:
 - 1. Bolts, screws, and washers shall be stainless steel.
 - 2. Hex Nuts: Shall be stainless steel and include nylon inserts.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Provide hangers and supports for electrical systems with necessary channels, fittings, brackets, and related hardware for mounting and supporting materials and equipment. Provide anchor systems, concrete inserts, and associated hardware for proper support of electrical systems.
- B. Install equipment and devices on hangers and supports as shown on the Drawings, as specified, and as required.
- C. Install hangers and supports level, true, free of rack, and parallel and perpendicular to building walls and floors, so that the hangers and supports are installed in a neat, professional, workmanlike manner.
- D. Holes in suspended ceilings for rods for hangers and supports and other equipment shall be provided adjacent to bars, where possible, to facilitate removal of ceiling panels.

- E. Coordinate installation of hangers and supports with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment. Locate hangers and supports clear of interferences and access ways.
- F. Anchor Bolts, Expansion Anchors, and Concrete Inserts: Shall be in accordance with Section 05051, Anchor Systems, and requirements of this Section.
- G. Mounting of Conduit:
 - 1. Provide space of not less than 1/4-inch between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
 - 2. Fasten conduit to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.
 - 3. Devices shall be compatible with size of conduit and type of support. Following installation, size identification shall be visible and legible.
 - 4. Install conduit supports and fasteners in accordance with Section 16131, Rigid Conduits.
- H. Supports for Cabinets, Consoles, Panels, Enclosures, and Boxes:
 - 1. Freestanding: Unless otherwise specified or shown on the Drawings, provide supports for floor-mounted equipment, cabinets, consoles, panels, enclosures, and boxes. Such supports shall be 3.5-inch high concrete equipment base with a 45-degree chamfered edge. Base shall extend two inches beyond outside dimensions of equipment on all sides.
 - 2. Wall-Mounted:
 - a. Provide space not less than 1/4-inch between cabinets, consoles, panels, enclosures, and boxes and the surface on which each is mounted. Provide non-metallic or stainless steel spacers as required.
 - b. Do not mount equipment, enclosures, panels, and boxes directly to beams or columns. Mount struts to beams or columns using beam clamps, and mount equipment, enclosures, panels, and boxes to the struts.
 - 3. Floor Stand Rack:
 - a. Where equipment, cabinets, consoles, panels, enclosures, and boxes cannot be wall-mounted, provide an independent floor stand rack.
 - b. Floor stand rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended materials and equipment.
 - c. Equip floor stand racks with brackets and bases for rigidly-mounting the framework to the ceiling or floor, as applicable; or equip floor stand racks with beam clamps, angle plates, washers, and bolts for fastening to beam flanges, as applicable.

- d. When equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
 - 1) Main vertical supports of floor stand rack assemblies shall be back-to-back struts.
 - 2) Bracing, clamping and anchoring of each floor stand rack shall be sufficient to ensure rigidity of the floor stand rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, and wireway installed. Floor stand racks shall not be deflected more than 1/8-inch by a 100-pound force applied at any point on the floor stand rack in any direction.
- I. Drilling into beams or columns is not allowed unless authorized by ENGINEER.
- J. Tighten nuts and bolts to the manufacturer's recommended torque values.
- K. Field Cutting:
 - 1. Cut edges of strut and hanger rod shall have rounded corners, edges beveled, and burrs removed. If field cutting the strut is required, use clean, sharp, dedicated tools. Remove oil, shavings, and other residue of cuttings prior to installation.
 - 2. Coatings:
 - a. Coat cut edges of steel components with zinc-rich cold galvanizing spray coating according to manufacturer's instructions.

END OF SECTION 16070

NO TEXT ON THIS PAGE

SECTION 16075

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 13400, Instrumentation and Control.
3. Section 16122, Low-Voltage Electrical Power Conductors and Cables.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 110, Requirements for Electrical Installation.
2. NEC Article 210, Branch Circuits.
3. NEC Article 215, Feeders.
4. NEC Article 504, Intrinsically Safe Systems.
5. NEC Article 700, Emergency Systems.
6. NEC Article 701, Legally Required Standby Systems.
7. NEC Article 702, Optional Standby Systems.
8. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
9. NFPA 70E, Electrical Safety in the Workplace.

1.03 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following:
 - a. Complete description and listing of proposed electrical identification and electrical identification devices for associated equipment or systems.
 - b. Conduit and wire identification numbering system and equipment signage.

2. Product Data:

- a. Manufacturer's literature, cut sheets, specifications, dimensions, and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.01 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):

1. Nameplates:

- a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
- b. Size: As required.
- c. Letter Size: Minimum 3/16-inch.
- d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.

2. Legend Plates:

- a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
 - 1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
- b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:

1. Cable Tray Safety Signs:

- a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86139 by Brady.
 - 2) Or approved equal.
- b. Cable tray safety signs shall be pressure-sensitive vinyl conforming to 40 CFR 1910.145, 5 inches by 3.5 inches in size, and shall read, "DANGER – HIGH VOLTAGE"

2. Low-Voltage Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86060 by Brady.
 - 2) Or approved equal.
 - b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
3. Low-Voltage Markers:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) CV442xx by Brady.
 - 2) Or approved equal.
 - b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.
- C. Arc-flash Safety Labels:
 1. Warning labels will be provided by ENGINEER based on power system studies in Section 16215, Electrical Power Distribution System Studies.
- D. Service Fault Current Label:
 1. Products and Manufacturers: Provide one of the following:
 - a. Brady.
 - b. Or approved equal.
 2. Label shall be adhesive-backed polyester.
 3. Label shall be custom printed based on power studies in Section 16215, Electrical Power Distribution System Studies.
 4. Label shall indicate:
 - a. Nominal system voltage.
 - b. Maximum available fault current.
 - c. Date of calculation.
- E. Voltage System Identification Directories:
 1. General:
 - a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
 - b. Directories shall identify all voltage systems within building or structure.

- c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
- d. Colors shall be in accordance with Section 16122, Low-Voltage Electrical Power Conductors and Cables.
- e. Example Directory Text:

Voltage System Identification		
System	A, B, C	Neutral
480Y/277	Brown, Orange, Yellow	Gray
208Y/120	Black, Blue, Red	White

- 2. Large directories for rooms shall have text height not less than 1/2-inch.
- 3. Small directories for equipment shall have text height of not less than 1/4-inch.

F. Conduit Labels:

- 1. Products and Manufacturers: Provide one of the following:
 - a. Marking Services Inc.
 - b. Or approved equal.
- 2. All conduits shall be identified with conduit labels unless otherwise specified.
- 3. Do not label flexible conduit.
- 4. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
- 5. Conduit labels shall convey the following information:
 - a. Conduit number, as shown on the Drawings. Branch conduits shall be numbered the same as the main conduit with a letter suffix (e.g. the first branch from C-7103 shall be numbered C-7103A, the continuation branch C-7103B, the next branch C-7103C, etc.)
 - b. All conduits without a conduit number, such as lighting and receptacle conduits, shall have one of the following labels:
 - 1) 120 Volts [Power or Control].
 - 2) 120/208 Volts Power.
 - 3) 277/480 Volts Power.
 - 4) 24 VDC Control.
 - 5) Instrumentation/Signal.
 - 6) Telephone.
 - 7) Network.
 - 8) Fiber Optic.

- 9) Fire Alarm.
- 6. Labels shall be fastened with stainless steel or plastic wire tie-wraps.
- 7. Labels shall be made from a black and white laminate producing white lettering on a black background.
 - a. Size: 1 x 2-1/2" minimum.
 - b. Two holes on each end, 3/16" diameter or as required to accommodate tie-wraps.
- G. Wire Identification:
 - 1. Heat Shrinkable Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) 3PS by Brady.
 - 2) Or approved equal.
 - b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
- H. Detectable Underground Warning Tape:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Indentoline by Brady.
 - b. Or approved equal.
 - 2. Material: Polyethylene or polyester with detectable metal core and polyester underlamine.
 - 3. Width: Two inches.
 - 4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.
- I. Thermal Printing System:
 - 1. Utilize thermal transfer process to provide non-smearing labels and markers.
 - 2. Wire and Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) M610 Label Maker by Brady.
 - 2) Or approved equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) BradyPrinter i5100 Label Printer by Brady.
 - 2) Or approved equal.

3. Cable Markers:

- a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) M710 Label Printer by Brady.
 - 2) Or approved equal.
- b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) BradyPrinter S3100 Sign and Label Printer by Brady.
 - 2) Or approved equal.

2.02 FABRICATION

A. Engraved Identification Devices (Nameplates and Legend Plates):

- 1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.

B. Engraved Identification Devices (Nameplates and Legend Plates):

- 1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
- 2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
- 3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
- 4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
- 5. On switchgear, provide nameplates for each main and feeder circuit including control fuses, and for each indicating light and instrument.
 - a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
 - b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
- 6. Motor Control Centers:
 - a. Provide nameplate with 1.5-inch letters with motor control center designation.

- b. Identify individual door for each unit compartment with nameplate identifying controlled equipment.
- 7. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
- 8. Push Buttons:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Provide green buttons for stop function.
 - d. Provide black buttons for other functions.
- 9. Pilot Lights:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Red	Running, Open
Green	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

- 10. Selector Switches:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
- 11. Panel Mounted Instruments:
 - a. Provide nameplates for identification of function.
- 12. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
 - a. Provide nameplates for identification.
 - b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTORS other submittals. Install nameplates with adhesive.

- c. Interior items requiring nameplates include:
 - 1) Terminal blocks and strips.
 - 2) Bus bars.
 - 3) Relays.
 - 4) Rear of face-mounted items.
 - 5) Rear of door-mounted items.
 - 6) Interior mounted items that require identification when mounted externally.
- d. Circuit Breaker Directory:
 - 1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.

13. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:

- 1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
 - a. Install rigid safety signs using stainless steel fasteners.
 - b. Clean surfaces before applying pressure-sensitive signs and markers.
- 2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
- 3. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
 - a. Label cable trays that contain conductors greater than 600 volts with cable tray safety signs.
 - b. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.
 - c. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
 - d. Do not label cable trays that contain only instrument signal cables.
 - e. Label cable trays that contain intrinsically safe wiring or cables in accordance with NEC Article 504.
- 4. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
- 5. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories

1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
 - a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
 - b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Arc-flash Safety Signs:

1. Provide arc-flash safety signs as required by NEC Article 110. Arc-flash safety signs are in addition to the arc-flash safety labels provided by ENGINEER.
2. Provide signs for switchgear, switchboards, panelboards, motor control centers, industrial control panels, and fused disconnects.
3. Label shall be Brady 94913 or equal.

F. Conduit Labels:

1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.
3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
4. Conduit labels shall indicate the following information:
 - a. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".
 - a. Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
6. Conduit labels shall be installed at the following locations:
 - a. Near each end of run of conduit.
 - b. Where conduit enters or exits walls, ceilings, floor, or slabs.
 - c. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures. Labels are not required at conduit bodies used as pull points.
 - d. At intervals of not more than 50 feet along the length of the conduit.

7. Orient conduit labels to be readable.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors shall comply with Section 16122, Low-Voltage Electrical Power Conductors and Cables.
2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
3. Do not provide labels for the following:
 - a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
4. Provide wire and cable labels for the following:
 - a. New, rerouted, or revised wire or cable.
 - b. Insulated conductors.
 - c. Wire and cable terminations:
 - 1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
 - 2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
 - a) Label individual conductors in a cable after breakout as specified for wires.
 - d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
 - 1) Label wires or cables within two inches of entrance to conduit.
 - e. Wire or cable in junction boxes and pull boxes
 - 1) Label wires or cables within two inches of entrance to conduit.
 - f. Wire and cable installed in cable tray.
 - 1) Wire and cable shall have labels at maximum intervals of 20 feet.
 - g. Wire and cable installed without termination in electrical manholes.
 - 1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.
5. Wire and Cable Identification System:
 - a. Wire and cable labels shall be imprinted with an identifying designator. Tags shall match identification in project as-built drawings and/or approved respective submittal(s).
 - 1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.

- b. Field Wiring:
 - 1) Wire or cable designator shall consist of:
 - a) Characters shall be alphanumeric and make wire designator unique.
 - b) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
 - c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
 - 1) New Cabinets, Consoles, Panels, and Enclosures:
 - a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 13400, Instrumentation and Control.
6. Modified Cabinets, Consoles, Panels, and Enclosures:
- a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a character designator equivalent to field wire designator.
- H. Terminal Strip Labeling:
- 1. Label panel side of terminal to match panel wire number.
 - 2. Label field side of terminal to match field wire number.
- I. Generator System Warning Signs:
- 1. Provide warning signs for generator systems as required by NEC.
 - 2. Install generator location warning sign on or immediately adjacent to service equipment, or to "normal" source disconnecting means when generator is located out of sight of service equipment or disconnecting means.
 - 3. Install generator grounding warning sign on enclosure or immediately adjacent to point where generator neutral is connected to grounding electrode system if connection is made remote from generator.
- G. Docking Station Labeling:
- 1. Provide labeling for docking station according to Article 700.3(F)(3) of the National Electrical Code. The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.

END OF SECTION 16075

NO TEXT ON THIS PAGE

SECTION 16080

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - b. D923, Standard Practice for Sampling Electrical Insulating Liquids.
 - c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
 - e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
 - f. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
 - h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
 - i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
 - j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
 - b. 48, Standard Test Procedures and Requirements for Alternating- Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5kV through 500kV.
 - c. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
 - d. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
 - e. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

- f. C2, National Electrical Safety Code.
- g. C37.20.2, Standard for Metal-Clad Switchgear.
- h. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
- i. C62.33, Standard Test Specifications for Varistor Surge- Protective Devices.
- 3. Insulated Cable Engineers Association (ICEA):
 - a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
 - b. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
- 4. National Electrical Manufacturers Association (NEMA):
 - a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - b. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
- 5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70B, Recommended Practice for Electrical Equipment Maintenance.
 - c. 70E, Standard for Electrical Safety in the Workplace.
 - d. 101, Life Safety Code.
- 7. National Institute for Certification in Engineering Technologies (NICET).
- 8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

- 1. Submit 90 days prior to performing inspections or tests:
 - a. Schedule for performing inspection and tests.
 - b. List of references to be used for each test.
 - c. Sample copy of equipment and materials inspection form(s).
 - d. Sample copy of individual device test form.
 - e. Sample copy of individual system test form.

2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
 - a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
 - b. Staged sequence of initial energization of electrical equipment.
 - c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
 - d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
 - a. In accordance with Section 01782, Operation and Maintenance Data.
 - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on removable media of as-left setpoints, programs, and device configuration files for:
 - a. Protective relays.
 - b. Intelligent overload relays.
 - c. Reduced-voltage soft starters.
 - d. Power metering devices.
 - e. Electrical communications modules.
 - f. Automatic transfer controllers.
6. Submittals and electronic formatting shall be in accordance with Section 01330, Submittals.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.

6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
 7. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.
 8. All testing shall be by the same company.
- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.
- C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

- A. Perform inspection and electrical tests after equipment listed herein has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.
- C. Inspection and electrical tests on energized equipment shall be:
1. Scheduled with Owner prior to de-energization.
 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- D. Notify Owner at least 2 weeks prior to performing tests on energized electrical equipment.
- E. No equipment will be energized prior to all applicable testing specified herein has been approved. The Contractor shall allow at least two submittals to be approved for each equipment in the schedule. Contractor shall coordinate the testing of all equipment with the approved schedule.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 GENERAL

- A. Perform tests in accordance with requirements of 01751, Starting and Placing Equipment in Operation.
- B. Testing shall be performed on all electrical equipment provided in this Contract for equipment types specified herein, even if other testing is required as part of the equipment specification. Tests and inspections shall establish:
1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
 2. Installation operates properly.
 3. Equipment is suitable for energization.
 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective relays, circuit breakers, fuses, power monitoring meters, and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies provided by Others.
- E. Adjust mechanisms and moving parts of equipment for free mechanical movement.
- F. Adjust and set electronic relays and sensors to correspond to operating conditions, as recommended by manufacturer, or Section 16215, Electrical Power Distribution System Studies.
- G. Verify nameplate data for conformance to Contract Documents and approved Submittals.
- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screwdriver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Inform OWNER and ENGINEER of working clearances not in accordance with NFPA 70.
- N. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.
- O. Electrical Enclosures:
 - 1. Remove foreign material and moisture from enclosure interior.
 - 2. Vacuum and wipe clean enclosure interior.
 - 3. Remove corrosion found on metal surfaces.
 - 4. Repair or replace, as determined by Owner door and panel sections having dented surfaces.
 - 5. Repair or replace, as determined by Owner poor fitting doors and panel sections.
 - 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 - 7. Replace missing or damaged hardware.
 - 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.

- b. If required because of extensive damage, as determined by Owner, refinish entire assembly.
 - P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.
- 3.02 CHECKOUT AND STARTUP
- A. Voltage Field Test:
 - 1. Check voltage at point of termination of supply system to Project when installation is essentially complete and is in operation.
 - 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
 - B. Equipment Line Current Tests:
 - 1. Check line current in each phase for each piece of equipment.
 - 2. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.
- 3.03 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES
- A. Visual and Mechanical Inspection:
 - 1. Insulator damage and contaminated surfaces.
 - 2. Proper barrier and shutter installation and operation.
 - 3. Proper operation of indicating devices.
 - 4. Improper blockage of air-cooling passages.
 - 5. Proper operation of drawout elements.
 - 6. Integrity and contamination of bus insulation system.
 - 7. Check door and device interlocking system by:
 - a. Closure attempt of device when door is in OFF position.
 - b. Opening attempt of door when device is in ON position.
 - 8. Check nameplates for proper identification of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbutton.
 - c. Control switch.
 - d. Pilot light.
 - e. Control relay.
 - f. Circuit breaker.

- g. Indicating meter.
 - h. Automatic transfer controller.
- 9. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.
- 10. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench thermographic survey applied to bolted joints.
 - a. Ohmic value to be zero.
 - b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
 - c. Thermographic survey temperature gradient of 2 degrees C or less.
- 11. Check operation and sequencing of electrical and mechanical interlock systems by:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.
 - c. Key exchange to operate devices in OFF-NORMAL positions.
- 12. Verify performance of each control device and feature.
- 13. Control Wiring:
 - a. Compare wiring to local and remote control and protective devices with elementary diagrams.
 - b. Proper conductor lacing and bundling.
 - c. Proper conductor identification.
 - d. Proper conductor lugs and connections.
- 14. Exercise active components.
- 15. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. With switches and breakers open.
 - e. With switches and breakers closed.
 - f. Control wiring except that connected to solid state components.

- g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
- 2. Overpotential Tests:
 - a. Applied ac or dc voltage and test procedure in accordance with C37.20.1 and NEMA PB 2. Alternatively use NETA ATS, Table 100.2.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. Test results evaluated on a pass/fail basis.
- 3. Current Injection Tests:
 - a. For entire current circuit in each section.
 - b. Secondary injection for current flow of 1 ampere.
 - c. Test current at each device.
- 4. Control Wiring:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
- 5. Operational Test:
 - a. Initiate control devices.
 - b. Check proper operation of control system in each section.

3.04 PANELBOARDS

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 - 2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 3. Check panelboard mounting, area clearances, and alignment and fit of components.
 - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - 5. Perform visual and mechanical inspection for overcurrent protective devices.
- B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
 - 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

- b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. With switches and breakers open.
 - e. With switches and breakers closed.
 - f. Control wiring except that connected to solid state components.
 - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.05 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

- 1. Physical and insulator damage.
- 2. Proper winding connections.
- 3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
- 4. Defective wiring.
- 5. Proper operation of fans, indicators, and auxiliary devices.
- 6. Removal of shipping brackets, fixtures, or bracing.
- 7. Free and properly installed resilient mounts.
- 8. Cleanliness and improper blockage of ventilation passages.
- 9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
- 10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - c. Results temperature corrected in accordance with NETA ATS, Table 100.14.

- d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - e. Insulation resistance test results to compare within 1 percent of adjacent windings.
- 2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.06 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

- 1. Inspect each individual exposed power cable No. 6 and larger for:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
 - d. Color coding conformance with specification.
 - e. Proper circuit identification.
- 2. Mechanical Connections For:
 - a. Proper lug type for conductor material.
 - b. Proper lug installation.
 - c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
- 3. Shielded Instrumentation Cables For:
 - a. Proper shield grounding.
 - b. Proper terminations.
 - c. Proper circuit identification.
- 4. Control Cables For:
 - a. Proper termination.
 - b. Proper circuit identification.
- 5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

- 1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors and 500-volt dc megohmmeter for 300-volt insulated conductors.

- b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
 - c. Evaluate ohmic values by comparison with conductors of same length and type.
 - d. Investigate values less than 50 megohms.
 - 2. Continuity test by ohmmeter method to ensure proper cable connections.
- 3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS
- A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.
 - B. Visual and Mechanical Inspection:
 - 1. Proper mounting.
 - 2. Proper conductor size.
 - 3. Feeder designation according to nameplate and one-line diagram.
 - 4. Cracked casings.
 - 5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
 - 6. Operate breaker to verify smooth operation.
 - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
 - 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.
 - C. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
 - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
 - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
 - d. Test values to comply with NETA ATS, Table 100.1.
 - 2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each pole.
 - b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
 - 3. Primary Current Injection Test to Verify:
 - a. Long-time minimum pickup and delay.
 - b. Short-time pickup and delay.
 - c. Ground fault pickup and delay.

- d. Instantaneous pickup by run-up or pulse method.
- e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
- f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
- g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

- 1. Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
- 2. Ground bus connections in motor control center, panelboard, switchboard, and switchgear assemblies for proper termination and tightness.
- 3. Effective transformer core and equipment grounding.
- 4. Accessible connections to grounding electrodes for proper fit and tightness.
- 5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

- 1. Fall-of-Potential Test:
 - a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
 - b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
- 2. Two-Point Direct Method Test:
 - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
 - b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.
- 3. Neutral Bus Isolation:
 - a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
 - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
 - c. Investigate values less than 50 megohms.

3.09 ELECTRIC MOTORS

- A. See Section 16150, Electric Motors, for inspection and testing requirements.

3.10 SINGLE BREAKER GENERATOR DOCKING STATION

- A. See Section 16266, Single Breaker Generator Docking Station, for inspection and testing requirements.

3.11 PAD MOUNTED LIQUID FILLED TRANSFORMERS

- A. See Section 16273, Pad Mounted Liquid Filled Transformers, for inspection and testing requirements.

3.12 MEDIUM VOLTAGE CABLE

- A. See Section 16123, Medium Voltage Cable, for inspection and testing requirements.

3.13 MEDIUM-VOLTAGE MOTOR STARTERS

- A. See Section 16349, Medium-Voltage Motor Starters, for inspection and testing requirements.

3.14 MOTOR CONTROL CENTERS

- A. See Section 16423, Motor Control Centers, for inspection and testing requirements.

3.15 MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES

- A. See Section 16310, Medium-Voltage Fusible Interrupter Switches, for inspection and testing requirements.

END OF SECTION 16080

NO TEXT ON THIS PAGE

SECTION 16121

INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
2. Types of cables include the following:
 - a. Shielded instrumentation cables.
 - b. Data communication cables.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16075, Identification for Electrical Systems.
3. Section 16131, Rigid Conduits.

1.02 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:

1. "CPE" means chlorinated polyethylene.
2. "FEP" means fluorinated ethylene-propylene.
3. "XLPE" means cross-linked polyethylene.

1.03 REFERENCES

A. Standards referenced in this Section are:

1. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
2. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
3. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling (requirements and restrictions of Technical Service Bulletins (TSBs) apply.)
4. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).
5. UL 13, Power-Limited Circuit Cables.
6. UL 1581, Electrical Wires, Cables and Flexible Cords.

7. UL VW-1, Vertical Wire Flame Test.
8. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
2. NEC 727, Instrumentation Tray Cable.
3. NEC 800, Communications Circuits.

1.05 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.

B. Informational Submittals: Submit the following:

1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General:

1. Cables shall bear the UL label.

B. Single Shielded Pair Instrument Cables:

1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or approved equal.
2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.

C. Single Shielded Triad Instrument Cables (RTD Cables):

1. Manufacturers: Provide products of one of the following:
 - a. Belden 1031A.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or approved equal.
2. Tinned copper, PVC insulation, stranded conductors, not less than no. 16 AWG, twisted triad, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC jacket. Rated for not less than 300 volts, 105 degrees Celsius UL Temperature rating, and complying with UL 1685 FT4 loading, NEC type CMG, ITC and PLTC.

D. RS-485 CABLE:

1. Manufacturers: Provide products of one of the following:
 - a. Belden 9841.
2. 120 Ohm characteristic impedance, 24 AWG tinned stranded copper conductors, twisted pair with polyethylene insulation and overall foil shield, 90% tinned copper braid, PVC outer jacket. Rated for not less than 300 volts, 80°C UL Temperature, and complying with UL 1685. NEC type CM.

E. Cable Terminals:

1. Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Insulug.
 - c. Or approved equal.
2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

F. Horizontal Unshielded Twisted Pair (UTP) Cables:

1. Horizontal cabling is cabling between and including the telecommunications outlet/connector and patch panel or termination block.
2. Manufacturers: Provide products of one of the following:
 - a. Bertek.
 - b. Belden.
 - c. Mohawk
 - d. Or approved equal.
3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, solid conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.

4. Comply with ANSI/TIA/EIA-568, Part 10.2.
5. Riser-rated where installed in conduit. Other installations shall be plenum-rated.
6. Rated for Category 6 use.

G. Patch Cords:

1. Patch cords are used for connecting patch panel to hub, or wall jack to equipment.
2. Manufacturer: Provide products of one of the following:
 - a. BerteK.
 - b. Belden.
 - c. Mohawk
 - d. Or approved equal.
3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, stranded conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
4. Cables shall be riser-rated.
5. Rated for Category 6 use.
6. Cables shall incorporate integral strain relief into the connector at each end. Connectors shall be RJ45 plugs.
7. Provide the following patch cords:
 - a. One 10-foot cable per wall jack installed.
 - b. One 3-foot cable per every two wall jacks installed.
 - c. One 5-foot cable per every two wall jacks installed.

H. Connecting Hardware for Unshielded Twisted Pair (UTP) Cables:

1. Hardware used to terminate UTP cable shall comply with ANSI/TIA/EIA-568, Part 10.4.
2. Connecting hardware shall be compatible with wiring specified in the Contract Documents.
3. Rated for Category 6 use.
4. Connecting hardware shall utilize 110-type terminal blocks to coordinate with patch panels and termination blocks specified the Contract Documents.
5. Telecommunications Outlets/Connectors:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Hubbell.
 - 2) Or approved equal.

- b. Outlets and connectors shall utilize RJ45 (eight-pin modular) plug/receptacle configuration.
- c. Outlets and connectors shall utilize T568B pin/pair assignments and be coordinated with wire type (solid or stranded conductor).
- d. Outlets shall be flush-mount type or surface-mount type, as indicated on the Drawings.

I. Patch Panels:

- 1. Manufacturers: Provide products of one of the following:
 - a. Black Box.
 - b. Or approved equal.
- 2. Patch panels shall utilize RJ45 (eight-pin modular) plug/receptacle configuration and utilize T568B pin/pair assignments for receptacles.
- 3. Coordinate patch panel terminations with wire type (solid or stranded conductor).
- 4. Patch panels shall be wall-mount type or rack-mount type, as indicated on the Drawings.
- 5. Listed as Category 6.
- 6. Provide quantity of ports not less than the quantity of wall jacks installed in the building/area served, plus 50 percent additional as spares.

J. Cable Support Hardware:

- 1. Conduit:
 - a. Where conduit is shown or indicated on the Drawings, comply with Section 16131, Rigid Conduits.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. General:

- 1. Install cables complete with proper terminations at both ends.
- 2. Install in conduit separate from power cables, unless shown or indicated otherwise.
- 3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
- 4. Identify conductors in accordance with Section 16075, Identification for Electrical Systems.

5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
6. Install in accordance with Laws and Regulations, including NEC.

3.03 FIELD QUALITY CONTROL

A. Site Tests:

1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
 - a. Document testing of each cable. Cable listing shall include cable identification on both ends, cable start and end points including terminal identification at each end when applicable, conduit identification (size, overhead or underground, label), and a description of the cable use or service.
2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
3. Replace with new cables the full length of cables that fail test.
4. Test equipment shall be provided by CONTRACTOR.
5. For testing of communications cables, test equipment used shall comply with the following:
 - a. Equipment shall consist of a "master" and a "remote" unit.
 - b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
 - c. Test unit shall be capable of storing all test results internally and printing the results later.
 - d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.
6. Cable testing shall be completed prior to equipment startup and before energizing equipment.

END OF SECTION 16121

SECTION 16122

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
2. Types of cabling required include:
 - a. Insulated cable for installation in raceways.
 - b. Cable for installation in cable trays.
 - c. Direct-burial cable.
 - d. Direct-burial cable duct.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 02316, Earthwork.
3. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2. ASTM B3, Specification for Soft or Annealed Copper Wire.
3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
4. ASTM D3485, Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
5. ASTM F2160, Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
6. NEMA TC 7, Smooth Wall Coilable Electrical Polyethylene Conduit.
7. UL 44, Thermoset-Insulated Wires and Cables.
8. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 300, Wiring Methods.
2. NEC Article 310, Conductors for General Wiring.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.

B. Informational Submittals: Submit the following:

1. Field Quality Control Submittals:
 - a. Written results of field insulation resistance tests.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Insulated Cable in Raceways:

1. Application: Use for circuits located indoors and outdoors.
2. Manufacturers: Provide products of one of the following:
 - a. Southwire.
 - b. The Okonite Company.
 - c. American Insulated Wire
 - d. General Cable
 - e. Or approved equal.
3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2, USE-2, or RHW-2 complying with UL 44. Insulation shall be 600V.
4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.

B. Cable Connectors, Solderless Type:

1. Products and Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Hylug.
 - c. Or approved equal.
2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90-degree C, 600 volts.

C. Cable Splices:

1. Products and Manufacturers:
 - a. Compression-Type Splices: Provide one of the following:
 - 1) Burndy Hylink.
 - 2) T&B Color-Keyed Compression Connectors.
 - 3) Or approved equal.
 - b. Spring Connectors: Provide one of the following:
 - 1) Buchanan B-Cap.
 - 2) T&B Wire Connector.
 - 3) Or approved equal.
2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

D. Wire and Cable Markers:

1. Provide wire and cable markers in accordance with Section 16075, Identification for Electrical Systems.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Factory-test wire and cable in accordance with UL standards.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:

1. Use insulating types of pulling compounds containing no mineral oil.
2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
3. Use dynamometer where mechanical means are used.
4. Cut off section subject to mechanical means.

- C. Bending Radius: Limit to minimum of six times cable overall diameter.

- D. Slack: Provide maximum slack at all terminal points.

E. Splices:

1. Where possible, install cable continuous, without splice, from termination to termination.
2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
3. Splices are not allowed in conduits.

F. Identification:

1. Identify conductors in accordance with Section 16075, Identification for Electrical Systems.
2. Identify power conductors by circuit number and phase at each terminal or splice location.
3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:

1. No. 8 AWG and Smaller: Provide colored conductors.
2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.

3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Grey Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	Grey Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Grey Brown Orange Yellow

3.02 FIELD QUALITY CONTROL

A. Site Tests:

1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
 - a. Document testing of each cable. Cable listing shall include cable identification on both ends, cable start and end points including terminal identification at each end when applicable, conduit identification (size, overhead or underground, label), and a description of the cable use or service.
2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.
4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.
5. Where existing cables are spliced to cables provided under the Project, test existing cables prior to splicing. Test cables at 1,000 VDC for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two megohms shall be brought to attention of ENGINEER and splicing shall not proceed until condition is acceptable.
6. Cable testing shall be completed prior to equipment startup and before energizing equipment.

END OF SECTION 16122

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SECTION 16123
MEDIUM VOLTAGE CABLES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install medium voltage cable.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. AEIC CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV.
2. ANSI C2, National Electrical Safety Code.
3. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems
4. ASTM B3, Specification for Soft or Annealed Copper Wire
5. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
6. ASTM B33, Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
7. ASTM B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
8. ICEA S-93-639, 5-46 KV Shielded Power Cables for use in the Trans-mission and Distribution of Electric Energy.
9. IEEE 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kv through 765kv.
10. IEEE 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500 000 V
11. UL 1072, Medium-Voltage Power Cables.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Agency:
 - a. Retain services of independent testing agency for field quality control testing of installed medium voltage cables.

- b. Testing agency shall have experience inspecting and testing cables, of the type specified, and shall be a NETA Accredited Company.
- c. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall be in accordance with ANSI/NETA ATS.

B. Regulatory Requirements:

- 1. Tests by Independent Agencies: Cable shall bear label of Underwriters Laboratories, Inc.
- 2. Cables shall be UL 1072 listed, cable shall conform to ICEA requirements. Cables shall meet or exceed the requirements of ICEA S-93-639 (NEMA WC74) and AEIC CS8.
- 3. Utilities:
 - a. Perform Work in connection with utility service in conformance with requirements of Northern Virginia Electric Cooperative (NOVEC).

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Literature identifying the methods and materials proposed for making splices and terminations. Submittal shall consist of manufacturer literature evidencing compatibility of conductor insulation, shield, and jacket of cable with splicing or terminating materials, and methods proposed for use.
 - b. Listing of locations where splices are proposed.
- 2. Product Data:
 - a. Manufacturer's literature and technical information indicating compliance with the Contract Documents.
- 3. Submittals and electronic formatting shall be in accordance with Section 01330, Submittals.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Certification from cable Supplier that cable installation is in accordance with cable manufacturer's recommendations.
- 2. Design Data: Cable pulling calculations from cable Supplier confirming that cable tensions will not be exceeded during installation.
- 3. Source Quality Control Submittals: Submit results of factory tests. Include testing procedures utilized.
- 4. Field Quality Control Submittals: Submit results of field quality control testing. Include testing procedures utilized.
- 5. Qualifications Statements:
 - a. Qualifications of splicing and termination personnel.

- b. Independent testing agency.
- C. Closeout Submittals: Submit the following:
 - 1. Record Documentation:
 - a. Include on record documents actual location and routing of medium voltage cable installations in accordance with Section 01780, Project Record Documents.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. General:
 - 1. Cable provided under this Section shall be rated for insulation level of 133 percent at 5, or 15, or 35 KV.
 - 2. Provide extruded semiconducting EPR strand screen, EPR insulation, extruded semiconducting EPR insulation screen, 5 mil bare copper helically applied tape shield and sunlight resistant PVC jacket.
 - 3. Cable shall be single conductor bearing UL 1072 label “MV 105” and comply with or exceed applicable ICEA S-93-639 (NEMA WC74) and AEIC CS8-13 standards.
- B. Manufacturers: Provide products of one of the following:
 - 1. Kerite Company.
 - 2. The Okonite Company.
 - 3. General Cable Corporation.
 - 4. Southwire.
 - 5. Or approved equal.
- C. Materials:
 - 1. Conductor: Conductors shall be soft or annealed uncoated or tinned coated copper with concentric-lay Class B round stranding in accordance with ASTM B8, and ASTM B3 or ASTM B33.
 - 2. Insulation System: Cable insulation system shall include two separate screen layers, primary insulation and shield.
 - a. Conductor screen shall consist of extruded inner layer of non-conducting energy suppression or semi-conducting material. Conductor screen shall be in intimate contact with outer surface of conductor.
 - b. Primary insulation shall be high quality ozone-resistant ethylene-propylene rubber-based compound. Insulation system shall be suitable for use at conductor temperatures not exceeding 90 degrees C for normal operation, 130 degrees C for emergency overload conditions, and 250 degrees C for short circuit conditions. Minimum and maximum thickness of insulation system shall be 85/120 mils for 5 kV systems, 210/220 mils for 15 kV systems, and 400/450 mils for 35 kV systems.

- c. Insulation screen shall be outer layer of thermosetting semi-conducting material. Insulation screen shall be in intimate contact with outer insulation surface.
 - d. Insulation shield shall be a 5-mil copper tape applied helically with minimum 12.5 percent overlap.
- 3. Jacket: Continuous jacket of moisture, heat, oil resistant black polyvinyl chloride shall be applied over insulation and shielding system. Minimum thickness of jacket shall be in accordance with ICEA.

D. Cable Connectors:

- 1. Connectors shall be copper, tin-plated, long-barrel compression type. Suitable for voltage applications up to 35 KV.
- 2. For sizes 250 MCM and larger, connectors shall be two-hole mount type with provisions for two bolts for joining to apparatus terminal.
- 3. Manufacturers: Provide products of one of the following:
 - a. Hubbell Burndy.
 - b. Thomas & Betts, Part of ABB Group.
 - c. Or equal.

E. Cable Terminations:

- 1. Cable terminations shall comply with Class 1 requirements of IEEE 48.
- 2. Terminations shall be molded elastomer, wet-process porcelain or 3M Cold Shrink types (or equal) with grounding provisions for cable shielding.
- 3. Manufacturers: Provide products of one of the following:
 - a. Elastimold.
 - b. G&W Electric Company.
 - c. Raychem Corporation.
 - d. 3M Company.
 - e. Or equal.

F. Cable Splices:

- 1. Make cable splices using standard splice kits that reinstate cable's insulation and jacket and continue metallic shielding through entire cable joint.
- 2. Splices shall be premolded, conventional tape or heat-shrinkable type.
- 3. Manufacturers: Provide products of one of the following:
 - a. Elastimold.
 - b. G&W Electric Company.

- c. Raychem Corporation.
- d. 3M Company.
- e. Or equal.

G. Pulling Compound:

- 1. Provide pulling compound to facilitate wiring pulling. Compound shall be UL-listed, waxed or water-based type. Compound shall be compatible with all jacket types.
- 2. Pulling tension coefficient of friction shall not exceed 0.35.
- 3. Use winter-grade compound for outdoor, low-temperature installations.
- 4. Manufacturers: Provide products of one of the following:
 - a. Ideal Industries.
 - b. Greenlee.
 - c. American Polywater Corporation.
 - d. Or equal.

H. Fireproofing Tape for Cables in Manholes, Handholes, and Boxes:

- 1. Tape shall be 30-mils thick of self-extinguishing material that does not support combustion. Tape shall not deteriorate when subjected to water, salt, sewage, or fungus.
- 2. Secure tape with glass cloth tape.

I. Color code cables by applying general purpose, flame-retardant tape, wrapped in overlapping turns covering an area of at least two inches. Colors shall be as follows:

- 1. Grounded Neutral: White.
- 2. Phase A: Brown.
- 3. Phase B: Orange.
- 4. Phase C: Yellow.

2.02 SOURCE QUALITY CONTROL

A. Factory Testing:

- 1. Cables shall be factory tested in accordance with testing standards of ANSI/NEMA WC 74/ICEA S-93-639 and UL.
- 2. Conductors shall comply with electrical resistance requirements of ICEA.
- 3. Perform insulation resistance test in accordance with ANSI/NEMA WC 74/ICEA S-93-639. Each cable shall have an insulation resistance not less than that corresponding to insulation resistance constant of 20,000 megohms-1000 feet at 15.6 degrees C.

4. Perform high voltage AC test in accordance with ANSI/NEMA WC 74/ICEA S-93-639.
5. Measure and record shield resistance from end to end on completed cable.
6. Corona Test: Each reel of completed shielded power cable shall be partial discharge tested in accordance with ANSI/NEMA WC 74/ICEA S-93-639.
7. Record cable physical measurements.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check for proper phase sequence and proper motor rotation. Installations shall conform to NEC Article 328 and IEEE 576.
- B. Splice and terminate medium voltage cables in accordance with cable manufacturer's recommendations.
 1. Use experienced personnel familiar with materials and procedures to be employed.
 2. Make splices watertight for below-grade installations, and submersible in manholes and handholes.
- C. Pulling:
 1. Refer to Paragraph 2.1 G for pulling compound requirements.
 2. Pulling tension shall be within limits recommended by cable manufacturer.
 3. Use dynamometer when mechanical means are used.
 4. Cut off section subject to mechanical means.
- D. Bending Radius: Limit to twelve times cable overall diameter.
- E. Slack: Provide maximum slack at terminal points and in manholes.
- F. Wrap cables located within manholes, handholes, and boxes, using 3M Fire-Retardant Electric Arc Proofing Tape 77, secured with 3M electrical tape 69, or approved equal. Cover cables with tape extending at least one inch into each duct.
- G. Identification: Identify conductors by circuit number and phase at each terminal or splice location.
- H. Installations shall conform to NEC Article 328 and IEEE 576.
- I. Coordinate replacement of service cable with Owner and utility.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Perform acceptance testing of medium voltage cable system. Each cable circuit shall be inspected and tested on an individual, per-phase basis.

2. Visual and Mechanical Inspection: Inspect each power cable installation in accordance with ANSI/NETA ATS. Inspect each splice and termination.
3. Electrical Tests: Perform electrical testing of each power cable in accordance with ANSI/NETA ATS and manufacturer's recommended testing procedures. Testing shall include:
 - a. Shield continuity test.
 - b. DC or AC high potential test.
 - c. Adhere to following procedures before performing over-potential tests:
 - 1) Disconnect all equipment, including but not limited to: transformers, switches, motors, circuit breakers, and surge arrestors from cable circuit to prevent test interruptions due to flashovers or trip-outs resulting from excessive leakage current.
 - 2) Establish adequate clearance between circuit test ends and grounded objects and to other equipment not under test.
 - 3) Ground all circuit conductors not being tested, all cables shields, and nearby equipment.
 - 4) Clean insulation surfaces.
 - 5) Keep cable ends dry.
 - d. Apply high-potential slowly in eight to ten equal steps to 80 percent of manufacturer's test value. Record leakage current at each test voltage and plot resulting curve on graph paper.
 - e. Stop the test if leakage current increases excessively or if a "knee" appears in the curve before reaching maximum test voltage.
 - f. Upon reaching specified maximum test voltage, maintain voltage for 15 minutes, record leakage current at 30 seconds, one minute, and at one-minute intervals thereafter. Plot leakage current versus time on the same graph as step voltage curve.
 - g. Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
 - h. Apply grounds for a time period adequate to drain all insulation stored charge.
 - i. Repair or replace and retest new cable that fails tests.
 - j. Test curves shall be signed by the individual performing tests and submitted to ENGINEER.
4. Where existing cables are spliced to cables provided under this Contract, new cable shall be high-potential tested prior to splicing. After new cable has been proven acceptable, make splice to existing cable and test insulation resistance of entire cable. Perform shield continuity test. When tests are positive, perform very low frequency (VLF) testing. Test voltage and procedures shall be in accordance with ANSI/NETA ATS and manufacturer's recommendations. Cable failures shall be brought to attention of ENGINEER in writing.

B. Cable Tension Field Quality Control: Testing and Supplier Services:

1. Provide services at the Site during cable installation to ensure that cable tensions are not exceeded. Provide cable splicing when tension exceeds cable manufacturer's recommendations.
2. Provide services of cable manufacturer's representative to prepare cable pulling calculations. Manufacturer's representative shall inspect, monitor, and assist in cable installation, and shall certify that cables have been correctly installed.
3. Required field services include:
 - a. Document, with assistance of manufacturer's representative, actual ductbank installation parameters needed to prepare cable pulling calculations.
 - b. Prepare pulling calculations in advance of cable installation.
 - c. Monitor actual pulling tensions during installation to ensure that recommended tensions are not exceeded.
 - d. Certify jointly with manufacturer's representative that cable installation is in accordance with cable manufacturer's recommendations.
4. Provide equipment, coordinate, and identify information necessary to ensure proper installation of cables. Contract Price shall include all costs associated with equipment, coordination, and identification of all information necessary for complete, functional system.

END OF SECTION 16123

SECTION 16131

RIGID CONDUITS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
2. When specific, detailed conduit routings for various systems within buildings and other areas are not be shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
3. Conduit types and the installation methods shall comply with the following, unless otherwise shown or indicated in the Contract Documents:
 - a. Use rigid metal conduit or intermediate metal conduit for exposed indoor conduit runs in non-corrosive areas.
 - b. Use PVC-coated rigid steel or aluminum conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
 - c. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.
 - d. Use Schedule 40 PVC or steel conduit for concrete-encased duct bank runs.
 - e. Use steel or Schedule 40 PVC conduit for conduit runs embedded in structural concrete slabs.
 - f. Use steel conduit for plant monitoring and control (PMCS) systems, system control and data acquisition (SCADA) systems, and communication systems, regardless of the installation. Conduit shall be PVC-coated rigid steel in hazardous, wet, and corrosive locations.

B. Coordination:

1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.
2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 05051, Anchor Systems.
3. Section 16070, Hangers and Supports for Electrical Systems.

4. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI C80.1, Standard for Rigid Electrical Steel Conduit (ERSC).
2. ANSI/NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
3. NEMA TC2, Electrical Polyvinyl Chloride (PVC) Conduit.
4. NEMA TC3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
5. NEMA TC14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
6. UL 6, Electrical Rigid Metal Conduit – Steel.
7. UL 514B, Conduit, Tubing, and Cable Fittings.
8. UL 651, Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
9. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
10. UL 1242, Electrical Intermediate Metal Conduit – Steel.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 342, Intermediate Metal Conduit
2. NEC Article 344, Rigid Metal Conduit.
3. NEC Article 352, Rigid Nonmetallic Conduit.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Assembly details of conduit racks and other conduit support systems.
 - b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Shop Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
2. Product Data:
 - a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.

B. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:

- a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.

2. Site Quality Control Submittals:

- a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.

C. Closeout Submittals: Submit the following:

1. Record Drawings:

- a. Show actual routing of exposed and concealed conduit runs in record documents.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Rigid Steel Conduit, Elbows, and Couplings:

1. Manufacturers: Provide products of one of the following:

- a. Allied Tube and Conduit.
- b. Wheatland Tube Company.
- c. Western Tube and Conduit Corporation.
- d. Or approved equal.

- 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.

B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:

1. Manufacturers: Provide products of one of the following:

- a. Robroy Industries.
- b. Perma-Cote Industries.
- c. OCAL, Inc.
- d. Or approved equal.

- 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.

- 3. Color: Color of coating shall be the same on all conduit and fittings.

C. Aluminum Conduit, Elbows, and Couplings:

1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Or approved equal.
2. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.

D. Metallic Conduit Fittings, and Outlet Bodies:

1. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or approved equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Materials shall comply with ANSI/NEMA FB 1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.

E. PVC-coated Conduit Fittings, and Outlet Bodies:

1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or approved equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall comply with ANSI/NEMA FB 1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Provide PVC-coated or aluminum conduit fittings and outlet bodies in hazardous, wet, and corrosive locations. Fitting material shall be consistent with conduit material.

F. Non-metallic Conduit and Fittings:

1. PVC Plastic Conduit:
 - a. Manufacturers: Provide products of one of the following:
 - 1) Amoco Chemicals Corp.

- 2) Carlon Electrical Products.
- 3) Or approved equal.
- b. Material: Schedule 40 PVC, rated for 90 degrees C, complying with NEMA TC3 and UL 514B and 651.
- c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

G. Conduit Hubs:

- 1. Manufacturers: Provide products one of the following.
 - a. Myers Electrical Products Company.
 - b. Or approved equal.
- 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
- 3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.

H. PVC-coated Conduit Hubs:

- 1. Manufacturers: Provide products one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or approved equal.
- 2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw, and factory coating of 40-mil thick PVC and smooth urethane interior coating.
- 3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.

I. Conduit Bushings and Locknuts:

- 1. Manufacturers: Provide products one of the following:
 - a. O-Z/Gedney.
 - b. Appleton Electric Company.
 - c. Or approved equal.
- 2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.

3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

J. Thruwall Seals

1. For new construction through exterior subsurface walls and exterior concrete walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type WSK and WSCS by O-Z/Gedney.
 - 2) Or approved equal.
2. For new construction passing through concrete floors and floor slabs.
 - a. Manufacturer: Provide one of the following:
 - 1) Type FSK and FSCS floor seals by O-Z/Gedney.
 - 2) Or approved equal.
3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
 - 2) Or approved equal.

2.02 ACCESSORIES

- A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
1. To Wood: Wood screws.
 2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05051, Anchor Systems.
 3. To Brick Masonry: Expansion bolts by Price or approved equal.
 4. To Concrete: Anchors in accordance with Section 05051, Anchor Systems.
 5. To Steel: Beam clamps in accordance with Section 16070, Hangers and Supports for Electrical Systems.
- B. Duct Sealing Compound
1. Soft, fibrous, slightly tacky, non-hardening sealing compound.

2. Remains workable at all temperatures.
3. Manufacturer:
 - a. Type DUX by O-Z/Gedney.
 - b. Or approved equal.

2.03 IDENTIFICATION

A. Conduit Labels:

1. Provide conduit labels in accordance with Section 16075, Identification for Electrical Systems.

B. Warning Tape:

1. Provide warning tape in accordance with Section 16075, Identification for Electrical Systems.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install in accordance with Laws and Regulations.

B. Supports:

1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 16070, Hangers and Supports for Electrical Systems.
2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.

D. Exposed Conduit:

1. Install parallel or perpendicular to structural members or walls.
2. Where possible, run conduit in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
3. Install on structural members in protected locations.
4. Locate clear of interferences.
5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.

6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.

E. Underground Conduits:

1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 02316, Earthwork and Fill.
3. Install warning tape 12 inches below finished grade over buried conduits.

F. Empty Conduits:

1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.

G. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

H. Joints:

1. Apply conductive compound to joints before assembly.
2. Make up joints tight and ground thoroughly.
3. Use standard tapered pipe threads for conduit and fittings.
4. Cut conduit ends square and ream to prevent damaging wire and cable.
5. Use full threaded couplings. Split couplings are not allowed.
6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.

I. Terminations:

1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
3. Use of bushings in lieu of locknuts is not allowed.
4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

J. Moisture Protection:

1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
2. Underground and embedded conduit connections shall be watertight.
3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.

4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.

K. Corrosion Protection:

1. Conduit Curb:

- a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide 4-inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.
- b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 1/2-inch above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.
- c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.
- d. Where the floor or pad mounted equipment enclosure will completely enclose the stub-up, the PVC coated rigid steel elbow may be omitted and the embedded conduit extended above the base terminating with an end bell. Where steel conduit is required for communication or other requirements, the PVC coated rigid steel elbow and any required PVC coated rigid steel extension shall be provided.
- e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.
- f. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit

2. Dissimilar Metals:

- a. Prevent occurrence of electrolytic action between dissimilar metals.
- b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
- c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.

L. Reused Existing Conduits:

1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.

3. Pull mandrel through conduit, if necessary, to remove obstructions.
- M. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 2.01.J.3 of this Section.
- N. Non-metallic Conduit:
1. Install in accordance with manufacturer's recommendations.
 2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
 3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
 4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures. See Paragraph 3.02.K.1 of this section.
- O. PVC-coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's recommendations.
 2. Install with manufacturer's installation tools to avoid damage to PVC coating.
 3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.
- P. Identify conduits, including spares, in accordance with Section 16075, Identification for Electrical Systems.
- 3.03 FIELD QUALITY CONTROL
- A. Site Tests:
1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
 2. Maintain a record, by number, of all conduits successfully tested.
 3. Repair or replace conduits that do not successfully pass testing, and re-test.

END OF SECTION 16131

SECTION 16132
FLEXIBLE CONDUITS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. UL 360, Liquid-Tight Flexible Steel Conduit.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.
2. Submittals and electronic formatting shall be in accordance with Section 01330, Submittals.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):

1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
2. Products and Manufacturers: Provide one of the following:
 - a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
 - b. Liqueflex Type L.A. by Electric-Flex Company.
 - c. Or approved equal.

B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):

1. Material: Flexible brass inner core with bronze outer braid and protective neoprene plastic coating. Steel, brass, or bronze end fittings. Minimum of 12 inches long.
2. Products and Manufacturers: Provide one of the following:
 - a. Type ECGJH or ECLK by Crouse Hinds Company.
 - b. Type EXGJH or EXLK by Appleton Electric Company.
 - c. Or approved equal.

C. Flexible Conduit Fittings:

1. Material and Construction: Malleable iron with zinc electroplate finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
2. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or approved equal.
3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.

D. PVC-Coated Conduit Fittings:

1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections and shall have an inside diameter not less than that of the corresponding standard conduit size.
2. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Permacote Industries.
 - c. OCAL, Inc.
 - d. Or approved equal.
3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.
- B. Install in conformance with the Laws and Regulations.

END OF SECTION 16132

NO TEXT ON THIS PAGE

SECTION 16135

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems.
3. Section 16070, Hangers and Supports for Electrical Systems.
4. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are.

1. AASHTO, Standard Specifications for Highway Bridges.
2. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pull, Junction, and Terminal Boxes:

1. General – Applicable to All Boxes:
 - a. Description and Performance Criteria:

- 1) Provide pull, junction, and terminal boxes rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 16050, General Provisions for Electrical Systems.
 - 2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.
 - b. Manufacturers: Provide products of one of the following:
 - 1) Appleton Electric Company.
 - 2) Crouse-Hinds Company.
 - 3) Hoffman Engineering Company.
 - 4) Or approved equal.
 - c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.
 - d. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.
 - e. Identification: Boxes shall be identified in accordance with Section 16075, Identification for Electrical Systems.
2. Materials and Construction – Dusty Locations:
 - a. Material: Welded and galvanized sheet steel of USS gauge.
 - b. Gasket: Oil-resistant gasket.
 - c. Access: Lift-off hinges and quick-release latches.
 - d. Material Thickness:
 - 1) Boxes with dimension two feet and smaller shall be 14-gauge.
 - 2) Boxes with dimension between two and three feet shall be 12-gauge.
 - 3) Boxes with dimension of three feet or more in any direction shall be 10-gauge.
3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
 - a. Rating:
 - 1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
 - 2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
 - b. Material:
 - 1) Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.

- 2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 304 or 316 stainless steel, as required by location.
 - 3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating or Type 304 or 316 stainless steel.
 - c. Gasket:
 - 1) Provide neoprene gaskets for wet and corrosive locations.
 - 2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.
 - d. Access: Stainless steel cover bolts.
 - e. Features:
 - 1) External mounting lugs.
 - 2) Drilled and tapped conduit holes.
 - 3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
 - 4) Provide threaded connections for explosion proof boxes.
- B. Terminal Blocks:
 - 1. Products and Manufacturers: Provide one of the following:
 - a. Allen-Bradley Company, Bulletin, Model 1492.
 - b. Or approved equal.
 - 2. Material and Construction:
 - a. NEMA-rated nylon modular terminal blocks.
 - b. 600-volt rated.
 - c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
 - d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.
- B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 16070, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.
- C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
 - 1. Conduit runs containing more than three 90-degree bends.
 - 2. Conduit runs exceeding 200 feet in length.
- D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.
- E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.
- F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.
- G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

END OF SECTION 16135

SECTION 16144
CONTROL STATIONS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems.
3. Section 16070, Hangers and Supports for Electrical Systems.
4. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
3. NEMA ICS 6, Industrial Control and Systems Enclosures.
4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
5. UL 508, Industrial Control Equipment.

1.03 QUALITY ASSURANCE

A. Component Supply and Compatibility:

1. Obtain all control stations furnished under this Section from a single control station manufacturer.
2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Listing of control stations to be furnished with their location, rating, and NEMA enclosure type for each.
2. Product Data:
 - a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Control Stations:

1. Manufacturers: Provide products of one of the following:
 - a. Cutler-Hammer.
 - b. General Electric Company.
 - c. Allen Bradley Company.
 - d. Square-D Company.
 - e. Or approved equal.
2. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
 - a. For locations requiring NEMA Type 4X panels, use plastic style Allen-Bradly 800H or equal.
 - b. For all other locations, use metal style Allen-Bradly 800T or equal.
3. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
6. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
7. Indicating Lights: 120V AC LED module, push-to-test. Indicating lights shall incorporate built-in 3mA shunting circuitry to provide true "on/off " status indication and eliminate the

need for additional components to offset the effects of leakage current. Lens color shall be in accordance with Section 16075, Identification for Electrical Systems.

8. Enclosures: As required for area classifications specified in Section 16050, General Provisions for Electrical Systems, and complying with NEMA 250 and NEMA ICS 6. Plastic or fiberglass enclosures are not permitted.
9. Identification: Identify enclosures in accordance with Section 16075, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install equipment as shown and indicated and provide sufficient access and working space for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 16070, Hangers and Supports for Electrical Systems.

END OF SECTION 16144

NO TEXT ON THIS PAGE

SECTION 16150

ELECTRIC MOTORS

PART 1 - GENERAL

1.01 SCOPE

- A. Work described in this Section includes furnishing all labor, materials, equipment, tools, and incidentals required for a complete and operable installation of all electric motors. All electric motors shall be installed, adjusted, tested, and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.
- B. This Section shall also include the minimum standards to be followed by repair centers in servicing and converting two existing 350 HP 2300 VAC, three phase, General Electric induction motors to 4160 VAC operation.
 - 1. Whatever the anticipated repairs, the first steps shall be to ascertain and document the complete condition of the motor or motor parts as received in the repair center.
 - 2. Commencing with the motor or motor parts in their assembled condition and proceeding through all stages of whatever assembly is needed to complete the evaluation, the "as received" condition of all components shall be recorded. Such description shall include, but not be limited to:
 - a. General cleanliness
 - b. Cracked or broken welds or castings
 - c. Missing hardware
 - d. Wear or rub marks
 - e. Evidence of overheating
 - f. Looseness of winding ties, slot wedges, hardware, lead lugs, or bearings in their housings
 - g. Corrosion or moisture
 - h. Lack of, or poor condition of, bearing lubricant
 - i. Damaged or missing lubricant piping, fittings, gauges, or other accessory devices
 - j. Movement of the rotor on the shaft, or the stator in the frame.
 - 3. Photographs of any deficiencies found shall be included as part of the repair report. In the absence of clear photographs, any drawings, diagrams, or descriptions of conditions found shall allow no uncertainty as to the location of such conditions.

- C. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. CONTRACTOR shall supply all parts, devices, and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01330, Submittals. In addition, the following specific information shall be provided:
 - 1. Expected efficiency values, amperage, and power factor for operation at 100, 75, 50, 25 and 0 percent load.
 - 2. Bearing life certificate.
 - 3. Starting characteristics, including torque and locked rotor current.
 - 4. Motor nameplate data.

1.03 QUALITY ASSURANCE

- A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
 - 1. IEEE 112, Test Procedure for Polyphase Induction Motors and Generators
 - 2. NEC, National Electrical Code
 - 3. NEMA MG 1, Motors and Generators. (This Section's references to NEMA MG 1 followed by a hyphen and number, such as "NEMA MG 1-20.14", indicate the associated NEMA MG 1 paragraph reference.)
 - 4. UL 1004, Electric Motors
 - 5. Rebuilt electric motor assemblies shall have a third-party listing and labeling approved by the local Authority Having Jurisdiction. See Section 16050, General Provisions for Electrical Systems

1.04 QUALITY STANDARDS

- A. Motors shall be designed, manufactured, and tested in accordance with the latest revisions of the following standards:
 - 1. NEMA Standards
 - 2. IEEE Standards
 - 3. ANSI Standards
 - 4. UL Standards
- B. Manufacturers offering products that comply with these specifications include:

1. RAM Industrial Services
 2. Or approved equal
- C. Repair centers must have a known or recognized quality control program in place. All relevant testing equipment must be calibrated and calibration certificates available upon request.

1.05 STORAGE

- A. Motors shall be stored in a conditioned space with motor space heaters energized. When motors are to be inactive in excess of 30 days, the Contractor shall maintain the bearings and rotate the shaft twice a month for the duration of the inactive period.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these specifications, unless otherwise indicated.
- B. Unless otherwise specified, all AC motors shall be squirrel cage induction type, rated for continuous duty at service conditions specified herein.
- C. All motors shall have a service factor of 1.15.
- D. Motors with synchronous speeds of 1,800 rpm or higher shall have full load current not exceeding the values in NEC Table 430.250. Motors with synchronous speeds of 1,200 rpm shall have full load current not exceeding 110 percent of the above values.
- E. Motors shall be rated for a 40 degrees C ambient temperature unless specifically indicated otherwise.
- F. Motors shall have a grounding terminal in the motor terminal junction box. The bolt which attaches the grounding lug to motor terminal junction box shall not be used for any other purpose (such as mounting the box to the motor).

2.02 MOTOR CONDUIT BOXES

- A. Conduit boxes shall be of adequate size to permit terminating leads. It shall be possible to rotate these boxes in steps of 90 degrees. Conduit box shall be of adequate size and shall have a sufficient number of correct size openings to accept, all required conduits. (See Electrical Drawings for size and number of conduits).
- B. Torque Classification: Motors shall match the torque requirements of the driven equipment.

2.03 RATING

- A. Horsepower (HP): As noted. Where no value is noted, match the requirements of the driven equipment.

- B. Phase:
 - 1. Less than ½ HP: Single Phase
 - 2. ½ HP and Larger: Three-Phase
- C. Voltage:
 - 1. Single Phase Motors: 115/230 volt, 1 phase, 60 Hz
 - 2. Three-Phase Motors: 4160 volt, 3 phase, 60 Hz
- D. Speed, Revolutions Per Minute (RPM): Match existing nameplate.
- E. Torque and Starting Current: Torque shall match or exceed existing motors.
- F. Insulation and Temperature Rise: Class H insulation with temperature rise in accordance with Class B limits.

2.04 CONSTRUCTION

- A. Enclosure: Match existing.
- B. Windings: Copper
- C. Starting: Motor will be started with a medium voltage reduced voltage soft starter.

2.05 THREE-PHASE AC MOTORS

- A. General: Provide three-phase motors with the following features:
 - 1. Motor efficiency determined in accordance with NEMA MG 1-12.58.
 - 2. Minimum and nominal full-load efficiencies not less than those listed in: NEMA MG 1 Table 12-12 for motors rated 600 volts and smaller, and NEMA MG 1 Table 12-13 for motors rated larger than 600 volts and equal to or less than 5,000 volts.
 - 3. Motors shall be constructed for operation on three-phase, 60 Hertz, alternating current system. Motor voltage and variable frequency operation, where required, shall be as specified in the Sections for the associated driven equipment. Voltage ratings shall be 200 volts for operation on 208-volt systems, 230 volts for 240-volt systems, 460 volts for 480-volt systems, 2300 volts for 2400-volt systems, and 4000 volts for 4160-volt systems.
 - 4. Unless otherwise required by the load, motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G for motors 20 hp and larger.
 - 5. Motor frame shall be a rigid structure, constructed to maintain the lamination in correct alignment, and shall not depend on lamination or bolts for rigidity.
- B. Bearings:
 - 1. Provide bearings to match or exceed existing bearing design.

C. Insulation:

1. Insulation systems shall be rated Class H, with a service factor of 1.15 times motor's nameplate horsepower rating when operated on a sine wave power supply, and a service factor of 1.00 on an adjustable frequency power supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with ambient temperature not exceeding 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.
2. Windings shall be epoxy-coated. Treat windings with insulating compound suitable for protecting against moisture, salt air, and slightly acidic and alkaline conditions.
3. Motors for outdoor service and all motors larger than 200 hp shall have vacuum/pressure-impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in temperature-controlled oven.
4. Stator windings and end turn connections shall be fully brazed to withstand full voltage starting, regardless of the starting method indicated in the Section for the associated driven equipment. Bracing system shall essentially eliminate coil vibration under the high-current conditions of starting as well as during normal operation. When a tied system is used, system shall be such that no tie depends on the integrity of another tie within the system.
5. Motors larger than 200 hp shall be form wound. Form wound coils with micaceous ground wall insulation shall have additional insulation and hot-pressed to provide sealed system. Complete stator shall be vacuum/pressure-impregnated.

D. Enclosures:

1. Motor enclosure rating shall match existing motor.
2. Motor conduit box shall be split from top to bottom, shall be capable of being rotated to four positions 90 degrees apart, and shall comply with the following:
 - a. Box shall be gasketed with rubber-like gaskets between frame and conduit box and between conduit box and conduit box cover.
 - b. Provide box or opening in motor housing with conduit hub type fitting to allow threaded conduit connections.
 - c. Box sizes shall be in accordance with code requirements and shall accommodate medium-voltage terminations or stress cones, when required.
 - d. Protective and auxiliary devices shall terminate in auxiliary conduit boxes.
 - e. Terminal leads shall be flexible and of sufficient length to extend for distance of not less than ten inches beyond face of terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with non-wicking, non-hygroscopic insulating material, or insulating "wrap-cap" as manufactured by Ideal Industries, or equal.

- f. Provisions for terminal box size, length of leads, size of conduit openings, and type of terminal lugs shall be complied with irrespective of other standards or practice.
 - g. Provide motor frame grounding stud inside conduit box. Stud shall include a drilled and tapped hole.
 - E. Lifting Eyes: Motors weighing more than 50 pounds shall include at least one lifting eye or lifting lug. Construct motor and lifting eyes or lifting lugs to bear motor's full weight.

2.06 ACCESSORIES

A. General:

1. Provide lifting eyes for 182 and larger frame size.
2. Nameplate: Permanently affixed and stamped so as to permit recovery of the nameplate data in the event the nameplate is painted over.
3. Provide motor accessories in accordance with this Section unless specified otherwise in the Section for the associated driven equipment.
4. Provide space heaters in motors five horsepower and larger installed outdoors, and in enclosed motors five horsepower and larger installed indoors in unheated spaces.
5. Provide resistance temperature detector (RTD) type winding thermal protection for all motors larger than 200 hp.
6. Provide stator and bearing temperature detectors for each motor 250 hp and larger.

B. Space Heaters:

1. Space heaters for condensation prevention shall operate at 120 volts and shall be sized to provide approximately 10 degrees C temperature rise above ambient.
2. Heaters shall be low-density type for low surface temperature and long life.

C. Winding Thermal Protection:

1. RTDs shall be 100-ohm platinum three-lead type with calibrated resistance-temperature characteristics. Position detectors, two per phase for non-explosion proof motors and one per phase for explosion proof motors, to detect highest winding temperature and located between coil sides in stator slots. Detector leads shall be wired to a separate terminal box.

D. Bearing Thermal Protection:

1. RTDs shall be 100-ohm platinum three-lead type with calibrated resistance-temperature characteristics. Position detectors in drive end and non-drive end bearings. Detector leads shall be wired to the same terminal box as the winding detectors.

PART 3 - EXECUTION

3.01 GENERAL

- A. All motors shall be designed, manufactured, and tested in accordance with the latest edition of NEMA MG 1. All motors shall be able to start, accelerate, and drive the design load of the driven equipment without exceeding any of the specified design requirements.
- B. Finish shall be manufacturer's standard gray or ANSI 61 gray over a primer and rust inhibitor.

3.02 INITIAL TESTING

- A. Visually inspect the motor and record physical damage on the data sheet.

3.03 WINDING REMOVAL

- A. The windings are to be removed using a low temperature, hydraulic-mechanical system. Chemical stripping and stator burnout are not acceptable substitutes due to environmental problems and potential stator efficiency and reliability degradation.
- B. After the stator has been stripped it must be cleaned. This is to be performed by hand or sand/bead/cobb blasting the stator.
- C. A loop test is to be performed on the stator to look for hot spots. Once identified, hotspots must be corrected. If they cannot, the owner must be contacted for disposition.

3.04 REWIND REPAIR

- A. General: Wire sizes, turns per coil, coil pitch or span, and winding connections shall be redesigned for 4160 VAC operation. Any temperature sensors installed in or on the winding shall either be removed intact for reuse or shall be completely identified for proper replacement before their removal from the original winding.
- B. The insulation system used shall be rated for Class H operating temperature or higher.
- C. The system used for taping and VPI of all form wound coils shall be the ViPak system.
- D. Coils must be formed from continuous lengths of properly sized and insulated magnetic wire. Splices are not acceptable under any circumstances.
- E. Form wound coils must be insulated with a turn insulation of a minimum of one ½-lapped layer of mica-based tape.
- F. There must be enough tape to cause the coil to fit snugly into the slot without danger to the insulation when the coil is being inserted into the slot.
- G. Prior to installing each insulated coil into the stator, the coil shall be tested for shorts using the surge test defined in IEEE Std. 522-2023
- H. Coil Support:
 - 1. Spacer blocks inserted between adjacent coils shall be single or multiple thickness, as required, of Dacron felt, folded over at least once, to be compressed during insertion. Depth of spacers shall be at least equal to coil height. The final winding impregnation process shall saturate these spacers with

resin or varnish prior to oven cure. Spacers cut from flat, pre-cured sheet material shall not be used.

2. Coil support rings (Surge Rings) shall be replaced without change in either their cross-sectional area or minimum thickness in the direction at right angles to the stator bore thickness in the direction at right angles to the stator bore thickness in the direction at right angles to the stator bore axis. Steel rings may be replaced with epoxy glass rope or tape, provided that no welded attachments are involved and that the replacement rings fit into any support arms or blocks provided as part of the original design. Regardless of the practice followed in the original winding, in a replacement winding each individual coil shall be tied to all support rings.
 3. Intercoil connections shall be suitably supported and must be silver brazed.
 4. Coil support rings, spacers, blocks, etc. shall be installed to the same extent as originally present or as required for 4160 VAC operation.
- I. All form windings shall receive two VPI treatments. The cycles shall be determined by the manufacturer's and varnish specifications.
- J. All passages and machined surfaces shall have the varnish removed.
- K. The windings are to be tested upon completion and before assembly:
1. A megohm test is performed per table 1 and the temperature corrected (IEEE Std. 43-2000).
 2. A DC Hi Potential test is performed at a value calculated:
 $V_{DC} = (2E_m + 1000V) (1.7)$
Where E is the rated motor nameplate voltage.
 3. A Surge Comparison Test is performed at 5000 VAC.
 4. An impedance balance test is to be performed and the values checked to ensure that all three phases are within 3% of the average.
 5. Power is applied to the windings (10% of rated voltage) and a spin test is performed, when possible.

3.05 LEADS AND ELECTRICAL CONNECTIONS

- A. All lead cables from the winding into the motor terminal box shall be replaced and have insulation of a thermal class equivalent to that of the winding itself and be of at least the same total cross sectional conductor area as those originally installed. Joints between new cables and the winding itself shall be of at least the same total cross sectional conductor area as those originally installed. Joints between new cables and the winding itself shall be insulated using materials and methods compatible with the coil insulation system and with the motor environment.
- B. In a VPI insulated machine, all lead cables, whether for the main power leads or for connection to winding accessories, such as temperature detectors, shall be treated as necessary prior to impregnation so that resin does not wick into the cable strands such as to solidify them during cure.
- C. In no case shall any strands of cable be cut or bent back out of the lug barrel so as to more easily the cable into the lug. All strands must be fully attached to the lug.

- D. Where any cables pass across or against sharp metal edges of motor structural parts in the assembled machine, cable shall be appropriately sleeved or taped for mechanical protection of cable insulation against abrasion.

3.06 REASSEMBLY

- A. The repair center shall provide any missing or damaged screws, bolts, connectors, gaskets, wire tags, or nameplates.
- B. Reassemble and test the insulated outboard bearing, as applicable.
- C. Pre-Lubricate bearings and check clearances at three equally spaced locations and record data.
- D. Complete reassembly of motor and perform:
 - 1. Megger test
 - 2. Continuity test between phases

3.07 FINAL TESTING

- A. After the motor is completely reassembled, the repair center shall perform the following tests and record this data:
 - 1. Perform a four-hour run test at full speed and full rated voltage (if the repair center is unable to run the motor at full rated voltage, then the repair center must take exception to this and state the highest voltage that the repair center can operate the motor on) monitoring the following:
 - a. Voltage
 - b. Current
 - c. RPM
 - d. Vibration Analysis: Vertical, horizontal, and axial in acceleration, velocity, and displacement. Compare to original.
 - e. Motor winding temperatures (one set every 15 minutes)
 - f. Motor bearing temperatures (one set every 15 minutes)
 - 2. Perform a Polarization Index per IEEE 43-2013 at the Table 1 potential. Potential must be applied for 10 minutes with a recorded measurement every minute, or better. The results are to be graphed on standard graph paper and the 10-minute reading is to be divided by the 1-minute reading. The ratio must be 2.0:1 or better (above 8.0:1 should be checked for dry and brittle insulation systems) and there are to be no 'dips' in the graph.
- B. Paint motor.
- C. If possible, block the shaft into position for shipping.
- D. Provide a written report detailing electrical and mechanical testing.

3.08 INSTALLATION

- A. Verify clearances and alignment prior to operation.
- B. Lubricate in accordance with the manufacturer's instructions.
- C. Check rotation and correct as necessary.

END OF SECTION 16150

SECTION 16210

UTILITY SERVICES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install electric service and associated equipment at the Site.
2. Contractor shall perform the following Work regarding electric service:
 - a. Furnish 15 KV primary cable from top of electric utility riser pole to the proposed transformer. Install cable in existing underground conduit from pole to transformer. Coil cables at base of riser pole for final run up pole by electric utility.
 - b. Provide connections at the proposed transformer primary and install terminators at the utility riser pole.
 - c. Contractor is not required to perform work inside the approach distance of the utility distribution cables.
 - d. Provide transformer secondary cable, terminations, and conduits.
 - e. Obtain required county inspection/approval from the authority having jurisdiction prior to NOVEC re-energizing the service.
 - f. Connect temporary power to utility or alternative source as required in Section 01500, Construction Facilities and Temporary Controls (Above Ground).
3. Electric utility company, Northern Virginia Electric Cooperative (NOVEC), will furnish and install the following:
 - a. Metering transformers, meters, enclosure, and associated metering equipment.
 - b. Pole mounted fused cutouts.
 - c. Marking of cable for cutting and termination by Contractor.
 - d. Final connection of Contractor provided cable and terminators at riser pole to NOVEC equipment. Installation of cables and U-guard protection on pole.
4. NOVEC contacts for the Pope's Head Pumping Station Electrical Upgrades project include:
 - a. Cason Garrison
Supervisor, System Construction
Northern Virginia Electric Cooperative
Office Phone: 703.754.6786
Mobile Phone: 703.895.0239

- b. Mark DeChristopher
Manager System Construction
Northern Virginia Electric Cooperative
Office Phone: 703.754.6713
Cell Phone: 703.407.2498
- c. Ginger Hamlin
Northern Virginia Electric Cooperative
Office Phone: 703-754-6784

B. Coordination:

- 1. Contractor shall coordinate with electric utility company relative to electric service connections and requirements. Contractor shall make all necessary arrangements with electric utility.
- 2. The Contract Price as awarded includes all costs associated with providing electric service to the Site.
- 3. Owner will pay NOVEC directly for power and their services related to the Pope's Head Pumping Station Electrical Upgrades project.

C. Related Sections:

- 1. Section 01330, Submittals.
- 2. Section 01500, Construction Facilities and Temporary Controls (Above Ground)
- 3. Section 16123, Medium Voltage Cable.

1.02 REFERENCES

A. Standards referenced in this Section are:

- 1. Northern Virginia Electric Cooperative, Electrician's Guide (latest edition).
- 2. Northern Virginia Electric Cooperative, Commercial and Industrial Electric Service Guidelines for Developers & Builders (latest edition).

1.03 QUALITY ASSURANCE

A. Pre-installation Conference:

- 1. Prior to transmitting submittals for materials and equipment related to electrical service, and prior to installing materials and equipment associated with electrical service, arrange a conference at the Site with the following:
 - a. Electric utility company.
 - b. Supplier representatives (as required) for materials and equipment associated with electrical service.
 - c. Installers of other work related to and adjacent to electric service Work.
 - d. Engineer and Resident Project Representative (as applicable).
 - e. Other representatives directly concerned with performance of electric service Work.

2. Review at the conference the following relating to electrical service Work:
 - a. Review Project requirements including Contract Documents, approved Shop Drawings and other submittals, requests for interpretation transmitted by Contractor to Engineer, and other pertinent documents.
 - b. Review scope of Work and scope of utility company work.
 - c. Review required samples and submittals, both completed and to be completed.
 - d. Review proposed costs for work that will be invoiced by utility company.
 - e. Review status of Work related to utility services and Progress Schedule related to utility services.
 - f. Review availability of materials, tradesmen, equipment, and facilities required for progress, to avoid delays, and to protect the Work from damage.
 - g. Review required inspection, testing, certifying, and quality control procedures.
 - h. Review methods for complying with requirements of utility company.
3. Reconvene conference at earliest opportunity if additional information must be developed to conclude the required topics of the conference.
4. Record in writing discussions of conference and decisions and agreements and disagreements; and revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them. Furnish copy of record to each party attending and the Owner.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Manufacturer's literature and technical information, including technical specifications, indicating compliance with the Contract Documents for materials and equipment and construction procedures specified in this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Termination Equipment:

1. Termination equipment at the riser pole shall meet the requirements of Section 16123, Medium Voltage Cable and shall be approved by the electric utility company.
2. Lugs shall be two-hole design.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install electric service materials and equipment in accordance with requirements of electric utility company. Install materials and equipment in accordance with NESC.
- B. Install equipment in accordance with manufacturer's written recommendations.

END OF SECTION 16210

SECTION 16215

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. OWNER will provide all professional services required to perform an electrical power distribution system study based on CONTRACTOR provided information.
2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.
3. Electrical power distribution system studies provided by OWNER shall include:
 - a. Short-circuit study.
 - b. Protective device evaluation study.
 - c. Protective device coordination study.
 - d. Arc flash analysis.
4. Provide technical information on the electrical characteristics of the equipment provided by CONTRACTOR that will become part of the power distribution system and will be incorporated into the study.
5. CONTRACTOR shall employ the services of an independent NETA certified testing company, with demonstrated capability for calibrating and setting protective breakers and relays, subject to the approval of the OWNER. Breaker and relay calibration and setting of CONTRACTOR provided equipment shall be in accordance with the coordination study. Upon completion of the relay settings and calibration, a report shall be furnished documenting all relay settings, timing, calibration values and NETA testing.
6. CONTRACTOR shall provide all settings for relays and configurable devices that are not included in the coordination study related to the automatic transfer system, other specified protections, and local electrical utility requirements.
7. These studies shall include medium-voltage fusible interrupter switch; transformers TX-1, TX-2, and TX-3; switchgear SWGR-1; motor control center MCC-1; panelboards; motors; soft starters; existing to remain distribution equipment; and other electrical equipment installed by CONTRACTOR.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16075, Identification for Electrical Systems.
3. Section 16341, Medium-Voltage Metal Enclosed Switchgear.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers.
2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
3. IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
7. ANSI/NETA ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
8. NFPA 70E, Electrical Safety in the Workplace.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Test Engineer:

- a. Field engineer performing protective device setting, testing, calibration, and validation shall be experienced in type of testing required and testing equipment used for these devices.
- b. Field engineer shall be a NETA Certified Technician employed by a NETA Accredited Company and who has achieved NETA Certification at Level 4.

B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment outage for testing. Submit shutdown requests for each outage in accordance with Division 1 Specifications, Coordination with Owner's Operations.

B. Informational Submittals: Submit the following:

1. Test Reports:

- a. Results of field testing.

2. Qualifications Statements:

- a. Field engineer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:

- 1. Final settings of protective devices. Submit compilation of final settings and calibration results for each equipment lineup within 10 days of programming the associated protective devices.
- 2. Electronic Files: Submit on portable media the following:
 - a. Protective Devices:
 - 1) Settings for all microprocessor-based protective devices.
 - 2) Customized configuration files and associated software versions used to program the protective devices.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 PREPARATION

A. General:

- 1. Coordinate with OWNER's professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.

3.02 FIELD CONFIGURATION

A. Protective Device Settings:

- 1. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required.
- 2. Additional equipment configuration and settings are required by Section 16341, Medium-Voltage Metal Enclosed Switchgear. In addition to the protective device settings provided by the coordination study, relays shall be programmed by the switchgear equipment supplier to implement ZSI protection, automatic transfer controls, and other requirements of the Contract Documents.

3.03 FIELD TESTING

A. Site Tests:

- 1. Provide protective device field testing in accordance with manufacturers' recommendations. Devices shall be checked, configured, and tested for setting and proper operation. Field testing shall be by CONTRACTOR's field engineer, after

OWNER's electrical power distribution system study is completed. Field testing results shall be documented in a report that shall include final settings of protective devices.

2. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters in medium- and low-voltage equipment shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.

3.04 MAINTENANCE OF OPERATIONS

- A. Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Division 1 Specifications, Coordination with Owner's Operations. Submit testing procedures and schedules and obtain acceptance by OWNER and ENGINEER prior to starting testing and related Work.

END OF SECTION 16215

SECTION 16266

SINGLE BREAKER GENERATOR DOCKING STATION

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, testing, troubleshooting, training, and incidentals as shown, specified, and required to furnish and install a generator docking station. A breaker with an electronic trip unit shall be installed inside the docking station enclosure. Docking station shall be complete and operable at the end of the project.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 01782, Operation and Maintenance Data.
3. Section 16050, General Provisions for Electrical Systems.
4. Section 16075, Identification for Electrical Systems.
5. Section 16215, Electrical Power Distribution System Studies.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. UL 1008, Transfer Switch Equipment.
2. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 240, Overcurrent Protection.
2. NEC Article 700, Emergency Systems.
3. NEC Article 701, Legally Required Standby Systems.
4. NEC Article 702, Optional Standby Systems.

- 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. Docking station assembly shall be listed and labeled to UL 1008 and UL 50.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit the following:

- a. Listing of docking station to be provided, including ratings and location of each.
 - b. Manufacturer's technical information for products proposed, including catalog cuts, dimensions, and construction details of enclosures with conduit entry locations.
 - c. Wiring Diagrams for power, signal, and control wiring.
 2. Test Procedures: At least thirty days prior to actual factory and field testing, submit proposed testing procedures, methods and apparatus.
- B. Informational Submittals:
1. Source Quality Control Submittals: Submit reports of completed factory tests, including test results and procedures used for testing.
 2. Field Quality Control Submittals: Submit reports of completed field tests, including test results and procedures used for testing.
 3. Manufacturer's written instructions for transporting, handling, storing, and installing the products.
 4. Manufacturer's Reports: Written report of each visit to Site by manufacturer's service representative.
- C. Closeout Submittals
1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Furnish operation and maintenance manuals per Section 01782, Operation and Maintenance Data.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the Site to ensure uninterrupted progress of the Work.
- B. Docking station shall be fully wired and assembled at factory. Supplier shall provide unloading, lifting, and rigging instructions to CONTRACTOR.
- C. Comply with Section 01600, Materials and Equipment for transportation and handling of products, and storage and protection of products.

PART 2 – PRODUCTS

2.01 SYSTEM PERFORMANCE

- A. Provide single breaker generator docking station as specified for connecting temporary generator to step-up transformer as shown on Drawings.

2.02 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:

1. ASCO/Schneider Electric.
2. Trystar, Inc.
3. Or approved equal.

2.03 DOCKING STATION

A. General Requirements:

1. Generator docking station shall include multiple sets of Camlocks for connection of cords to a temporary generator. A breaker and phase rotation monitor shall be installed inside the docking station enclosure.

B. Standards and Performance:

1. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

C. Enclosures:

1. NEMA 3RX, freestanding, stainless steel enclosure.
2. Front and rear shall be accessible for maintenance.
3. Rear shall be accessible for permanent cabling. Front shall be accessible for temporary cabling.

D. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.

E. Generator connectors shall be 16 Series Camlok style mounted on gland plate.

1. Camlocks shall be color coded according to system voltage.
 - a. A phase –Brown
 - b. B phase –Orange
 - c. C phase –Yellow
 - d. N Neutral – White
 - e. G Ground – Green

2. Quantity and rating of Camlocks shall be appropriate for the ampacity shown on the Drawings using paralleled 4/0 generator cables rated 400 Amps each.

F. Circuit Breaker:

1. Circuit breaker shall be rated as shown and indicated on the Drawings. Breaker must be UL 489 Listed.
2. Circuit breaker shall be easily removable for service and maintenance.
3. Circuit breaker shall have removable electronic trip unit with LSIG protections.
4. Provide energy reduction maintenance switch wired to breaker.

G. Permanent connectors shall be broad range set-screw type, located behind a physical barrier. See Drawings for cable quantity and sizes.

H. Accessories:

1. Provide strip heater and unit thermostat. Power shall be provided from external 120 VAC source.
2. Provide two sets of two-wire auto start connections.

I. Short Circuit & Withstand Rating

1. Shall be minimum 65 kAIC minimum unless otherwise indicated on drawings.

J. Factory Installed Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and shall be factory installed.

K. Identification: Identify docking station per Section 16075, Identification for Electrical Systems.

2.04 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests that shall include:

1. Physical inspection and checking of components.
2. Mechanical operation and device functional tests.
3. Control operation and functionality tests.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Install equipment in accordance with Contract Documents and manufacturer recommendations.
- C. Securely fasten equipment to floors, walls, or other surfaces on which equipment will be mounted. Provide additional structural components as required to ensure secure mounting.
- D. Configure breaker trip settings as defined in Section 16215, Electrical Power Distribution System Studies.

3.03 FIELD QUALITY CONTROL

- A. Perform field testing and inspection of each docking station. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform OWNER and ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of OWNER.
- B. Adjust, set, and test circuit breaker according to procedures in Section 16080, Commissioning of Electrical Systems.

3.04 MANUFACTURER SERVICES

- A. Manufacturer Services:
 - 1. Manufacturer's factory-trained representative shall test the system as specified in Article 3.3 of this Section. Representative shall operate and test system in the presence of ENGINEER and verify that equipment conforms to requirements.
 - 2. Manufacturer's factory-trained representative shall adjust the breaker settings determined by Section 16215, Electrical Power Distribution System Studies.
 - 3. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
 - 4. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
 - 5. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.
- B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products. Training requirements, duration of instruction, and other requirements shall be in accordance with Section 01800, Equipment and System Training.

END OF SECTION 16266

NO TEXT ON THIS PAGE

SECTION 16271

DRY-TYPE LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type low-voltage distribution transformers.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems.
3. Section 16061, Grounding and Bonding for Electrical Systems.
4. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. NEMA ST-20, Dry Type Transformers for General Applications.
2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
4. UL 1561, Dry Type General Purpose and Power Transformers.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule of transformers to be furnished with ratings and other required technical data.
 - b. Proposed location for each transformer, including pad layout, dimensions, and appurtenances.
2. Product Data:
 - a. Supplier's technical information for transformers proposed for use.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Dry Type Two-Winding Transformer:

1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
3. Insulation: Insulation and average winding temperature rise (in a 40-degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
6. Basic impulse level shall be 10 kV.
7. Sound Level: NEMA ST-20 standard.
8. Enclosure: UL listed for the application.
9. Identification: Identify transformers in accordance with Section 16075, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Manufacturers: Provide products of one of the following:

1. Cutler-Hammer.
2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Or approved equal.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.
- B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.
- C. Adjust tap settings to provide proper voltage at panelboards.
- D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

END OF SECTION 16271

NO TEXT ON THIS PAGE

SECTION 16273

PAD-MOUNTED, LIQUID-FILLED MEDIUM VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install pad-mounted, liquid-filled medium voltage transformers.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16075, Identification for Electrical Systems.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. IEEE C2, National Electrical Safety Code.
2. ANSI/IEEE C57.12, General Requirements for Distribution, Power and Regulating Transformers.
3. ANSI/IEEE C57.12.13, Liquid-Filled Transformers Used in Unit Installations including Unit Substations – Conformance Requirements.
4. ANSI/IEEE C57.12.22, Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High Voltage Bushings; 2500 kVA and Smaller.
5. ANSI/IEEE C57.12.27, Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations – Conformance Requirements.
6. ANSI/IEEE C57.12.28, Pad-Mounted Equipment Enclosure Integrity.
7. ANSI/IEEE C57.12.90, Test Code for Distribution Power and Regulation Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers.
8. ANSI/IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers.
9. ANSI/IEEE C57.93, Guide for the Installation of Liquid-Immersed Power Transformers.
10. ANSI/NETA ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
11. ANSI/NETA MTS, Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have not less than five years' experience in designing, manufacturing, and servicing equipment for installations of the size and type required for the Project. When requested by ENGINEER, submit list of installations in satisfactory operation.

B. Regulatory Requirements: Comply with the following:

1. NEC Article 450, Transformers and Transformers Vaults (Including Secondary Ties).
2. United States Department of Energy, 10 CFR Part 431, Energy Conservation.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Transformer layout including dimensions and locations of anchors and conduit entry areas. Drawings shall show and locate all accessories required by this Section.

2. Product Data:

- a. Manufacturer's technical information for proposed pad-mounted, liquid-filled medium voltage transformers.
- b. Anchorage system information with load calculations and installation information.

3. Testing Plans, Procedures, and Testing Limitations:

- a. Proposed factory test methods, procedures, and apparatus.
- b. Proposed field test methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:

1. Certifications:

- a. Seismic certification.

2. Source Quality Control Submittals:

- a. Submit transformer factory test reports.

3. Field Quality Control Submittals:

- a. Submit transformer field test reports.

4. Qualifications Statements:

- a. Manufacturer, when requested by ENGINEER.

1.05 DELIVERY AND HANDLING

- A. Equipment shall be constructed for handling by crane. Where cranes are not available equipment shall be suitable for placement on rollers using jacks to raise and lower the groups.
- B. Delivery, storage, and handling shall comply with manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 EQUIPMENT PERFORMANCE

A. Performance Criteria:

- 1. Rating: Liquid-Filled Medium Voltage Transformers shall be three-phase, 60 Hertz. Ratings shall be:

Parameter	TX-1	TX-2	TX-3
a. Quantity Required	1	1	1
b. KVA	2000	1500	112.5
c. Voltage connected primary	12.47 kV delta	480 V delta	4.16 kV delta
d. Voltage, connected secondary	4.16 kV wye	4.16 kV wye	480 V wye
e. KV BIL	95 pri/60 sec	30 pri/60 sec	60 pri/30 sec

2.02 MANUFACTURERS

A. Products and Manufacturers: Provide one of the following:

- 1. ABB.
- 2. Eaton.
- 3. Maddox Industrial Transformer.
- 4. Schneider Electric / Square D.
- 5. Or approved equal.

2.03 MATERIALS

A. Materials:

- 1. Coolant: Coolant shall be non-toxic, fire resistant, biological-based natural ester dielectric fluid. Coolant shall be 100-percent derived from edible seed oils and performance-enhancing additives shall be food grade. Coolant shall be FM-approved, UL-classified, Envirottemp FR3 fluid.
- 2. Efficiency: Energy efficient, complying with 10 CFR Part 431 standard efficiency levels.
- 3. Windings:
 - a. Copper construction for primary and secondary windings.
 - b. Winding temperature rise by resistance shall not exceed 55 degrees C.
 - c. Hottest spot winding temperature rise shall not exceed 65 degrees C.

- d. Provide thermally upgraded insulation allowing continuous loading of 112 percent of the 55 degrees C KVA rating with winding temperature rise not exceeding 65 degrees C and hottest spot temperature rise not exceeding 80 degrees C.
 - e. Windings shall be circular centered around stepped cores.
- 4. Taps: Full capacity, two 2.5-percent primary taps above normal and two 2.5-percent primary taps below normal.
 - 5. Liquid-filled medium voltage transformers shall bear the UL label.
 - 6. Impedance: 5.75 percent.

B. Construction:

- 1. Deadfront bushings for all medium voltage connections.
- 2. Construction shall be in accordance with ANSI/IEEE C57.12.13, ANSI/IEEE C57.12.22, ANSI/IEEE C57.12.27, and ANSI/IEEE C57.12.28.
- 3. Compartmental-type unit consisting of transformer tank with high and low-voltage cable terminating compartment, assembled as an integral unit for mounting on a pad.
- 4. Tamper-proof design with no exposed screws, bolts, or other fastening devices that are externally removable, and no openings through which foreign objects might contact live parts.
- 5. Full-height, air-filled, incoming and outgoing terminal compartments with hinged doors and steel barrier between compartments:
 - a. High-voltage, incoming compartment accessible only after door to low-voltage, outgoing compartment is open.
 - b. Compartment doors equipped for latching in the open position and capable of being secured with a single padlock.
 - c. Door hardware and hinge assemblies made of corrosion-resistant material.
- 6. Lifting, jacking, and rolling provisions.
- 7. Instruction Nameplate: Stainless steel plate and screws permanently affixed to a non-removable part in the low-voltage compartment and located to be readable with cables in place.
- 8. Transformer Tank: Sealed tank constructed with welded main cover and bolted tamper-resistant handhole for access to internal connections.
- 9. Tank grounding provisions in high-and low-voltage compartments.
- 10. Low-voltage Bushings: Tinned, spade type.
- 11. High-voltage Bushings: Porcelain, dead-front arrangement.
- 12. High-voltage Entrance: Three cast resin bushings with phase barriers between bushings.
- 13. Terminals arranged for cabling from below.

14. Identification: Identify pad-mounted liquid-filled medium voltage transformers in accordance with Section 16075, Identification for Electrical Systems, with transformer identification number, primary and secondary power identification, and voltage.

C. Accessories:

1. Lightning arrester mounting pads with three lightning and surge over voltage arrestors.
 - a. Lightning arresters shall be factory installed.
2. Gang-operated internal oil-immersed load break switch with bayonet primary expulsion fuses.
3. Fill plug and automatic pressure relief device.
4. Drain valve and sampler.
5. Tap changer handle.
6. Liquid-level gage.
7. Vacuum-pressure gage.
8. Dial-type thermometer with alarm contact.
9. Oil required to place transformer into service.

D. Finish

1. Liquid-filled medium voltage transformers shall include finish suitable for outdoor and indoor use, in accordance with the locations shown on the Drawings. Paint shall be an electro-statically deposited dry powder system applied to dry film thickness of not less than three mils. Paint products pad-mount green, Munsell No.7GY3.29/1.5.

2.04 SOURCE QUALITY CONTROL

A. Factory Tests for Liquid-Filled Medium Voltage Transformers: Perform the following factory tests in accordance with ANSI/IEEE C57.12.90 and ANSI/IEEE C57.12.91:

1. Resistance measurements of all windings on rated voltage connection of each unit and at tap extremes of one unit of each specified rating.
2. Ratio tests on rated voltage connection and on all tap connections.
3. Polarity and phase-relation tests on rated voltage connection.
4. No-load loss at rated voltage on rated voltage connection.
5. Exciting current at rated voltage on rated voltage connection.
6. Impedance and load loss at rated current on rated voltage connection of each unit and on the tap extremes of one unit of each specified rating.
7. Temperature Test: Perform tests when there is no available record of a temperature test made in accordance with ANSI/IEEE standards on a duplicate or essentially duplicate unit to the equipment required. Perform tests under conditions specified in ANSI/IEEE C57.12.90 on one unit of each specified rating.

8. Applied potential tests.
9. Induced potential tests.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install equipment in accordance with equipment manufacturer's recommendations, Laws and Regulations, and the Contract Documents.
- B. Install equipment with sufficient access and working for convenient and safe operation and maintenance.
- C. Install transformer on concrete pad at location shown on the Drawings. Modify pad as required to fit equipment furnished.
- D. Set taps for proper voltage at service distribution equipment.
- E. Unless otherwise shown or indicated, provide ground rod directly beneath transformer. Connect grounding electrode conductor(s) to ground rod. Where liquid-filled medium voltage transformers are to be mounted on existing concrete slabs, drill slab for ground rod penetration.
- F. Provide elbow connectors for medium voltage connections.

3.03 FIELD QUALITY CONTROL

- A. Site Tests:
 1. Following installation, inspect and test each transformer. Testing and inspection shall be in accordance with manufacturer's recommendations and performed by manufacturer's factory-trained technician. Manufacturer's technician shall inform CONTRACTOR and ENGINEER when the equipment is correctly installed. Do not energize equipment without OWNER's permission.
 2. Perform the following tests and checks before energizing equipment:
 - a. Inspect physical and mechanical condition, anchorages, alignment, and grounding.
 - b. Inspect all mechanical devices, gauges, and auxiliary devices for proper operation, indication, and liquid level.
 - c. Inspect all electrical connections to ensure connections are clean and bolts are tightened in accordance with manufacturer's recommendations using a calibrated torque wrench.
 - d. Tighten external bolts in accordance with manufacturer's recommendations and apply touchup paint to scratches.
 - e. Perform insulation resistance test.

- f. Perform turns ratio tests at all tap positions.
 - g. Perform high potential test.
- 3. Thirty days after completing the transformer testing and the transformers are placed into operation, obtain oil samples and perform insulating liquid testing for each transformer. Insulating liquid testing shall be performed in the laboratory in accordance with ANSI/NETA MTS, including optional testing.
- 4. Testing shall be performed by financially independent NETA accredited organization functioning as an unbiased testing authority.
- 5. Provide all testing equipment and services for testing the equipment specified.

B. Manufacturer's Services:

- 1. Furnish the services of qualified factory-trained technicians from manufacturer to instruct facility operations and maintenance personnel in recommended operation and maintenance of the equipment. Training requirements and duration of instruction shall be in accordance with Division 01800, Equipment and System Training.

END OF SECTION 16273

NO TEXT ON THIS PAGE

SECTION 16282
SURGE PROTECTIVE DEVICES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).
2. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems.
3. Section 16423, Motor Control Centers.
4. Section 16442, Panelboards.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/UL 1449, Surge Protective Devices.
2. IEEE C62.11, Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)
3. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
4. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
5. UL 1283, Electromagnetic Interference Filters.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five years of experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.

2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

C. Regulatory Requirements: Comply with the following:

1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
 - b. Components list and nameplate schedule.
 - c. Summary sheets with schedules of equipment.
2. Product Data:
 - a. Manufacturer's technical information, including catalog information.
 - b. Manufacturer's technical specifications with assembly and component ratings.

B. Informational Submittals: Submit the following:

1. Certifications:
 - a. Certification that SPD devices comply with standards referenced in this Section.
2. Source Quality Control Submittals:
 - a. Report of results of testing and inspections performed at manufacturer's shop.
3. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
4. Qualifications Statements:
 - a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the Following

1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01782, Operation and Maintenance Data.

- b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
 - 2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by ENGINEER in the operations and maintenance manual for the equipment.
- 1.05 DELIVERY, STORAGE, AND HANDLING.
 - A. Delivery:
 - 1. Upon delivery, check for evidence of water that may have entered equipment during transit.
 - B. Storage:
 - 1. Store SPD equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
 - 2. Protect equipment from corrosion and deterioration.
- 1.06 WARRANTY
 - A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
 - B. Special Warranty on Materials and Equipment:
 - 1. Provide manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of beneficial use.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Provide equipment of one of the following:
 - 1. General Electric.
 - 2. Schneider Electric/Square-D Company.
 - 3. Eaton/Cutler-Hammer.
 - 4. Or approved equal.

2.02 EQUIPMENT

- A. General:
 - 1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.

2. SPD shall comply with requirements of the following:
 - a. ANSI/UL 1449.
 - b. UL 1283.
 - c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.
 3. SPD shall be suitable for operation under the following environmental conditions:
 - a. Relative Humidity: Zero to 95 percent, non-condensing.
 - b. Frequency: 47 to 63 Hertz.
 - c. Temperature: Zero to 149 degrees F.
 4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
 5. SPD shall be suitable for internal and external mounting. Where shown on the Drawings, SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
 - a. Section 16423, Motor Control Centers.
 - b. Section 16442, Panelboards.
- B. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
1. Line-to-line.
 2. Line-to-neutral.
 3. Line-to-ground.
 4. Neutral-to-ground.
- C. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.
- D. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.
- E. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

- F. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.03 ACCESSORIES

- A. Provide SPD equipped with the following accessories:
1. Surge counter with display for indicating the number of surges detected.
 2. LED indicators for monitoring device status.
 3. Audible alarm and silence switch for indicating an inoperative condition.
 4. Dry contacts, "Form C", for remote annunciation of unit status.
 5. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD. When SPD is integral to switchgear, motor control center, panelboard, or other equipment, indicators, counter, alarm, and silence switch shall be visible and accessible from front of the equipment in which the SPD is installed.
 6. Enclosure for each externally-mounted SPD: NEMA rating shall be as required for area classifications specified in Section 16050, General Provisions for Electrical Systems.

2.04 SOURCE QUALITY CONTROL

- A. Perform manufacturer's standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer's recommendations, Laws, and Regulations, and the Contract Documents.
- B. Conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION 16282

NO TEXT ON THIS PAGE

SECTION 16310

MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install medium-voltage fusible interrupter switches.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16075, Identification for Electrical Systems.
3. Section 16080, Commissioning of Electrical Systems.
4. Section 16215, Electrical Power Distribution System Studies.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. IEEE C37.20.3, Metal-Enclosed Interrupter Switchgear.
2. IEEE C37.40, Service Conditions and Definitions for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.
3. NEMA SG-2, High Voltage Fuses
4. ISO 9000, Quality Management Systems- Fundamentals and Vocabulary.
5. ISO 9001, Quality Management Systems- Requirements.

1.03 QUALITY ASSURANCE

A. Qualifications.

1. Manufacturer:

- a. Manufacturer shall have experience producing substantially similar equipment to that specified, and, upon ENGINEER's request, shall submit documentation of not less than five installations in satisfactory operation.
- b. Manufacturer shall be ISO-9000 or ISO-9001certified for the equipment specified.
- c. Manufacturer of medium-voltage fusible interrupter switches shall be the same as that providing Section 16341, Medium-Voltage Metal Enclosed Switchgear.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Outline, summary sheets and equipment schedules.
 - b. Dimensional information, including front view elevation and floor plans.
 - c. Construction details of enclosures with conduit entry locations and connection details between assemblies.
2. Product Data:
 - a. Technical specifications with assembly and component ratings.
 - b. Time current curves for fuses.
 - c. Catalog cuts, components list, and nameplate schedule.
3. Testing Plans, Procedures, and Testing Limitations:
 - a. Thirty days in advance of scheduled dates for factory testing and field quality control testing, submit proposed testing procedures, methods, apparatus, and testing limitations.

B. Informational Submittals: Submit the following:

1. Source Quality Control Submittals:
 - a. Reports of completed factory testing, including procedures used and test results.
2. Field Quality Control Submittals:
 - a. Reports of completed field testing, including procedures and test results.
3. Qualification Statements:
 - a. Manufacturer, when requested by ENGINEER.
 - b. Calibration and certification of testing instruments.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, and description of operation.
 - b. Furnish operation and maintenance manuals per Section 01782, Operation and Maintenance Data.

D. Maintenance Material Submittals: Submit the following:

1. Spare Parts and Extra Stock Materials:

- a. Furnish, tag, and box for shipment and long-term storage the following spare parts and special tools for each medium-voltage fusible interrupter switch:

Item	Quantity per Medium-Voltage Switch
1.) Control fuses	Six per each type and size used
2.) Power fuses	One set for each type and size used

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping sections shall be designed and constructed to be shipped by truck, rail, or ship.
- B. Switches shall be equipped to be handled by crane. Where cranes are not available switches shall be suitable for placement on rollers using jacks to raise and lower the groups.

PART 2 PRODUCTS

2.01 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. Provide medium-voltage fusible interrupter switches consisting of an incoming compartment and three-wire, three-pole 600 ampere fused air interrupter switches. Line side and load side of switches shall be bottom fed. Switches shall be designed, constructed, and tested to meet the following standards:
 - a. IEEE C37.20.3, IEEE C37.40, ANSI/NEMA C37.57 and IEEE C57.13
 - b. NEMA SG-2.
2. Switches shall be UL listed and labeled.
3. Switch shall be suitable for use as service entrance equipment.

B. Performance Criteria: Ratings for medium-voltage fusible interrupter switches shall be:

1. Rated Maximum Voltage: 15 kV
2. Service Voltage: 12.47 kV
3. BIL: 60 kV
4. Switch Amperage Rating: 600 amperes, continuous
5. Momentary and duty cycle fault closing ratings of switches and interrupting rating of fuses shall equal or exceed the short circuit ratings of medium-voltage fusible interrupter switches.

2.02 MANUFACTURERS

A. Manufacturer: Furnish equipment manufactured by one of the following:

1. S & C Electric.
2. Eaton Cutler-Hammer.
3. Schneider Electric / Square D.
4. Or approved equal.

2.03 MATERIALS AND CONSTRUCTION

A. Structure:

1. Structure shall be metal-enclosed, dead-front, front-accessible, freestanding, dust-resistant, and fabricated of code-gage steel.
2. All steel parts shall be cleaned and a zinc-phosphate (outdoor equipment) or iron phosphate (indoor equipment) pre-treatment applied prior to paint application).
3. Outdoor equipment shall be weatherproof, NEMA 3R construction.
4. Paint color shall be ANSI-49 (medium light gray) TGIC polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.
5. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 16075, Identification for Electrical Systems.

2.04 AIR INTERRUPTER SWITCHES

A. Fused Air Interrupter Switch:

1. Rating: Three-pole, 600 ampere continuous. Switch shall be capable of interrupting full rated load.
2. Operation: Manually-operated interrupter switch, stored energy, gang-operated, quick-make/quick-break type, with separate main and arcing contacts and arc quenching chambers. Switch speed of opening and closing shall be independent of operator action. Provide auxiliary contacts to indicate when switch is in open and closed positions.
3. Operation: Interrupter switch shall be manually-operated, stored energy, gang-operated. Switch shall be quick-make/quick-break type, with separate main and arcing contacts and arc quenching chambers. Switch speed of opening and closing shall be independent of operator action. Provide auxiliary contacts to indicate when switch is in open and closed positions.
4. Provide interlocks to prevent:
 - a. Switch closing with switch or fuse compartment door open.
 - b. Opening of switch or fuse compartment door when switch is closed.

5. Enclosure:

- a. Each vertical section shall have a sloped weatherproof roof with labyrinth shaped joints. Use of gasket or caulking to make roof joints weatherproof shall not be permitted. All exterior openings shall be screened to prevent the entrance of small animals and barriered to inhibit the entrance of snow, sand, etc. The design shall be non-walk-in type.
- b. A minimum of one (1) 250-watt, 120-volt space heater shall be provided in each vertical section. Power for the space heater(s) shall be furnished from an external source as indicated on the drawings.
- c. Gasketed, ventilated, rodent-proof, and weatherproof.
- d. Removable lifting eyes. Blind tap sockets for lifting to prevent water entering the enclosure.
- e. Switch compartment shall have a sight window for visual inspection of switch contacts.
- f. Provisions for padlocking.

6. Fuses:

- a. Self-contained, expulsion type, sized as shown on Drawings.
- b. Ratings:
 - 1) Fuse Interrupting Rating: 14.4 kA Sym RMS
 - 2) Fused Switch Fault Close Rating: 23 kA Asym RMS
- c. Blown Fuse Indicator: Indicator shall operate to provide local indication of fuse operation.

7. Cable Connections:

- a. Furnish ground lug capable of #6-350 MCM cable.
- b. Provide provisions for connecting the size and quantity of cable in and cable out cables as shown on the Drawings.

2.05 SOURCE QUALITY CONTROL

- A. Tests and Inspection: Perform factory tests and inspection of equipment prior to shipment. Tests and inspections shall include the manufacturer's standard tests, including:
 - 1. Physical inspection, checking of all components and wiring checks.
 - 2. Switch operation, device functional tests and sequencing of control circuits.
 - 3. Primary, control, and secondary wiring dielectric tests.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install equipment on concrete bases in accordance with manufacturer's recommendations and instructions.

3.03 FIELD QUALITY CONTROL

A. Site Tests:

1. Provide field testing and inspection of medium-voltage fusible interrupter switches. After installation, inspect, adjust, and test switch. Testing and inspection shall be in accordance with manufacturer's recommendations and NETA Acceptance Testing Specifications (ATS). Testing and inspection shall be performed by NETA test firm as part of Section 16080, Commissioning of Electrical Systems. Inform OWNER and ENGINEER when the equipment has been correctly installed as indicated by the manufacturer's representative. Do not energize equipment without OWNER's permission.
2. Perform the following tests and checks before energizing equipment:
 - a. Verify proper installation of medium-voltage fusible interrupter switch and fuse sizes.
 - b. Inspect all mechanical interlocks for proper operation.
 - c. Check tightness of bolted connections. Torque to manufacturer's requirements.
 - d. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for 1 minute.
 - e. Measure insulation resistance of each switch pole-to-pole and from pole-to-ground for 1 minute.
 - f. Measuring contact resistance across each switchblade and fuseholder.
 - g. Verify proper operation of space heater.
 - h. Perform other tests and adjustments recommended by the equipment manufacturer.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct CONTRACTOR in installing equipment.
 - b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.

- c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
- 2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 2 hours. Representative shall operate and test the system in the presence of ENGINEER and verify that the equipment installation complies with the Contract Documents.
 - b. Second visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01800, Equipment and System Training.
 - 3) Number of hours on-Site shall be in accordance with 01800, Equipment and System Training.
 - c. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - d. Furnish services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of OWNER's request during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
- 3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

END OF SECTION

NO TEXT ON THIS PAGE

SECTION 16341

MEDIUM-VOLTAGE METAL ENCLOSED SWITCHGEAR

PART 1– GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install medium-voltage metal-enclosed front accessible switchgear, circuit breaker type.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16075, Identification for Electrical Systems.
3. Section 16215, Electrical Power Distribution System Studies.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/IEEE C37.20.3, IEEE Standard for Metal-Enclosed Interrupter Switchgear (1 kV–38 kV).
2. IEEE C37.04, Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
3. IEEE C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. IEEE C57.13, Performance and Test Requirements for Instrument Transformers of a Nominal System Voltage of 115 kV and above.
5. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. NEMA SG 4, Alternating Current High-Voltage Circuit Breakers.
7. NEMA SG 5, Power Switchgear Assemblies.
8. ISO 9000, Quality Management Systems – Fundamentals and Vocabulary.
9. ISO 9001, Quality Management Systems – Requirements.
10. CSA C22.2 NO 31, Switchgear Assemblies.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:

- a. Manufacturer shall have experience producing substantially similar equipment to that specified and shall be able to document at least five installations in satisfactory operation.
 - b. For equipment specified, manufacturer shall be ISO 9000 and ISO 9001 certified.
2. Independent Testing Firm:
- a. Field Quality Control: Retain an independent testing firm to perform field acceptance testing of the medium-voltage metal enclosed switchgear. Testing firm shall have experience in inspecting and testing of medium-voltage metal enclosed switchgear and be a member company of NETA.
 - b. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall be in accordance with ANSI/NETA ATS.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Outline, summary sheets and equipment schedules.
 - b. Unit control schematics and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
 - c. Three-line diagrams.
 - d. Dimensional information, including front elevation and floor plans. Floor plan shall indicate clearance requirements for maintenance and lift truck access.
 - e. Construction details of enclosures with conduit entry locations and connection details between assemblies.
 - f. Key interlock scheme and sequence of operation as shown and indicated on Drawings.
- 2. Product Data:
 - a. Technical specifications with assembly and component ratings.
 - b. Time current curves for protective devices.
 - c. Catalog cuts, components list, and nameplate schedule.
- 3. Testing Plans: Thirty days in advance of actual factory and field testing, submit proposed testing procedures, methods and apparatus.

B. Informational Submittals: Submit the following:

- 1. Manufacturer's Instructions: Instructions for handling, storing, installing, and start-up.
- 2. Source Quality Control Submittals:
 - a. 30 days prior to the witnessed test, the CONTRACTOR shall provide a factory witness test procedure to the ENGINEER and OWNER for review and approval.

- b. Reports of completed factory testing, including testing procedures used and testing results.
 3. Field Quality Control Submittals: Reports of completed field testing, including testing procedures used and testing results.
 4. Manufacturer's Reports: Reports of visits to Site by manufacturer's technical service representative, including descriptions of problems encountered and problem resolutions implemented.
 5. Qualifications Statements:
 - a. Manufacturer's qualifications and experience when requested by ENGINEER, including previous similar installations.
 - b. Independent testing firm.
- C. Closeout Submittals: Submit the following:
 1. Operations and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Submit operation and maintenance manuals in accordance with Section 01782, Operation and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 1. Spare Parts and Maintenance Materials:
 - a. Furnish, tag, and box for shipment and long-term storage the following spare parts and special tools for each medium-voltage metal enclosed switchgear lineup:

Item	Quantity per Medium-Voltage Metal Enclosed Switchgear Lineup
1) Circuit breakers, size per Drawings	In accordance with the Drawings
2) Manual ground and test device	One
3) Handle tool for manually charging breaker closing spring and manually opening shutter	One
4) Levering cranks for moving the breakers between test and connected positions	Two
5) Test jumper for operating the breaker while out of its compartment	One
6) Lifting device for installation/removal of breaker to/from its compartment	One
7) Protective device	One per each type used
8) Control relay	Five of each type used
9) Pilot light	One of each model used
10) Fuses	Two sets of each type and size used

- b. Furnish list of additional recommended spare parts for operating period of one year. Describe each part, quantity recommended, and current unit price.
- c. Package spare parts in suitable containers bearing labels clearly indicating contents and equipment with which they are to be used.
- d. Provide lifting device for installation/removal of breaker to/from its compartment.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping sections shall be designed to be shipped by truck, rail, or ship. Indoor sections shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- B. Medium-voltage metal enclosed switchgear shall be equipped to be handled by crane. Where cranes are not available switchgear shall be suitable for placement on rollers using jacks to raise and lower the groups.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

- A. Provide medium-voltage front-accessible metal enclosed switchgear in accordance with arrangement indicated on Drawings. Switchgear shall be a metal-enclosed assembly of breaker housings, auxiliary housings, and vacuum circuit breakers assembled with individual vertical steel sections bolted together to form a rigid metal-enclosed assembly.
- B. Performance Criteria: Ratings for medium-voltage metal enclosed switchgear lineup shall be:
 - 1. 4.16 KV nominal.
 - 2. 5 KV maximum design.
 - 3. 60 KV BIL.
 - 4. 1200 amperes, main bus, continuous.
 - 5. Short circuit ratings:
 - a. 65 kA peak close and latch.
 - b. 25 KA rated short circuit current at 4.16 KV.
 - 6. Short circuit current capability of breakers shall be in accordance with ANSI/IEEE C37.06.

2.02 MANUFACTURERS

- A. Manufacturer: Provide products of one of the following:
 - 1. Eaton Cutler-Hammer.
 - 2. Schneider Electric/Square D
 - 3. General Electric.

4. Or approved equal.

2.03 CONSTRUCTION

- A. Design, construct, and test front-accessible medium-voltage metal enclosed switchgear in accordance with the following standards.
 1. ANSI/IEEE C37.20.3
 2. ANSI C37.04.
 3. ANSI C37.09.
 4. NEMA SG 4.
 5. NEMA SG 5.
 6. CAN/CSA-22.2 No. 31-04.
- B. Medium-voltage metal enclosed switchgear structure shall be metal-enclosed, front-accessible, dead front, free standing, dust resistant, and fabricated of code gauge steel.
- C. The switchgear shall be front accessible such that it can be installed against the wall, and shall not require rear access for its maintenance, inspection, or operation. Primary bus joints and supports that are not accessible from the front are to be designed such that no maintenance is necessary for those joints or supports. All necessary access for owner's primary cable terminations, joining of main and ground bus joints at shipping splits, and termination of control wires shall be provided from the front or top of the switchgear. Access to primary cable terminals shall not require the removal of any primary or secondary devices.
- D. Access to any medium-voltage cable or bus connection shall be through removable panels requiring the use of tools and shall be marked with caution signs to indicate the presence of energized conductors behind them.
- E. Switchgear design shall allow safe installation and removal of all drawout elements into and from their compartments. No high voltage circuits shall be exposed to maintenance personnel when drawout element compartment doors are opened or drawout elements are removed from the compartment. No high voltage circuits shall be exposed when control compartment doors are opened. Clearly visible caution signs and warnings shall be placed on all removable covers or bolted panels provided for access to primary circuits and cables.
- F. All low voltage devices and their associated control wiring shall be isolated by grounded metal barriers from primary circuits with the exception of short lengths of wires such as at instrument transformer and space heater terminals. Space heaters shall be supplied when noted on the drawings or specified herein.
- G. Buses:
 1. Buses shall be copper with tin-plated connections. Ground bus shall be 1/4-inch by 2-inch minimum. Power and ground buses shall run the length of the medium-voltage metal enclosed switchgear. Provide connectors for 4/0 ground cable at each end of ground bus.
 2. Power bus supports, bus, and interconnections shall withstand stresses associated with short-circuit currents up through the close and latch rating of circuit breakers. Bus work momentary rating shall equal or exceed short circuit rating of circuit breakers.

3. Main bus shall be supported utilizing a high strength glass polyester support. Bus support devices within vertical sections shall have either molded fins of highly track-resistant Aramid Nylon or be glass polyester type A-20 insulators.
 4. Bus joints shall be plated, bolted, and insulated with boots.
- H. The following features shall be supplied on every compartment containing a drawout vacuum circuit breaker:
1. The compartment front door shall be capable of being safely opened. Barrier all high voltage parts with grounded metal, to provide full access to the front of the circuit breaker control faceplate and all low voltage control and instrumentation devices.
 2. The stationary primary high voltage contacts in each breaker compartment shall be silver-plated and recessed within insulating tubes. A metal safety shutter shall automatically cover those stationary high voltage contacts when the breaker is in the test or disconnected position or out of the cell. Provide provision for padlocking the shutters in an open position for inspection or in the closed position to prevent inadvertent contact with the stationary primary high voltage contacts, when the breaker is removed from its cell.
 3. Each compartment and circuit breaker shall be provided with mechanical interlocks to prevent the insertion of a circuit breaker into the compartment with a higher frame size or interrupting rating.
 4. Each circuit breaker shall have three positions within its compartment, with compartment door closed: Disconnected, Test, and Connected.
 - a. In the DISCONNECTED position, no primary high voltage or secondary control wiring connections shall be made and the safety shutters automatically close over the stationary high voltage contacts in the compartment.
 - b. The TEST position shall be same as the DISCONNECTED position, except secondary control wiring shall be connected so that the breaker can be opened or closed electrically or manually.
 - c. In the CONNECTED position, the circuit breaker shall be in the normal operating position inside the compartment, with safety shutters fully opened, and primary and secondary connections fully made. Provide a label or other marking on the compartment floor, visible when compartment door is opened, to indicate that the circuit breaker is fully connected.
 5. Provide cell switches with one form -C contact for breaker position status. Two switches shall be provided in each circuit breaker compartment. One switch shall change its state when breaker is moved to connected position, and the other switch shall change its state when breaker is moved to test/disconnected position. When additional contacts are required for controls or interlocking, provide auxiliary relays as required.
- I. Provide the following interlocks for each drawout circuit breaker to insure safe and proper operation:
1. It shall not be possible to engage levering crank and withdraw the breaker when the breaker is in the connected position and closed.

2. It shall not be possible to close the circuit breaker manually or electrically while it is being levered or while the breaker is in any position between the connected and the test/disconnected.
 3. It shall not be possible to insert the circuit breaker into the connected position if the circuit breaker control wiring connector is not properly engaged with its compartment control wiring connector. Interlocking shall also be provided to prevent disconnection of circuit breaker control wiring connector (manually or automatically) while the circuit breaker is in the connected position or in any position between the connected and the test/disconnected.
- J. Each auxiliary drawout compartment shall be provided with safety shutter to cover stationary high voltage connections when the auxiliary drawer is withdrawn from the connected position.
- K. Vertical section construction shall be of the universal frame type using die-formed bolted and welded parts. All enclosing covers and doors shall be fabricated from steel whose thickness shall be equal to or greater than those specified in ANSI/IEEE C37.20.3.
- L. Width, depth, and height of each vertical section containing circuit breakers or drawout auxiliary equipment shall not exceed 26-inches wide, 61.5-inches deep, and 92-inches high, excluding handles or other device projections on the door, skid, or lifting eye/angles. When a cable pull box is required adjacent to a single-high or two-high breaker structure, or when a bus transition section is required adjacent to a bus-tie breaker structure, width of such pull-box or transition section shall not exceed 19-inches. Assembled structure shall fit in space allocated on Drawings including NEC required working space.
- M. Switchgear structure shall be designed to accommodate the addition of a future switchgear section. This shall include removable panels and provisions for power and ground bus extensions. See Drawings for location of future section.
- N. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 16075, Identification for Electrical Systems.

2.04 CIRCUIT BREAKERS AND DEVICES

A. Circuit Breakers:

1. Circuit breakers shall utilize vacuum interrupters for interruption and switching functions. The current transfer between the circuit breaker and primary circuits conductors in the compartment shall be via heavily silver plated and spring loaded copper finger cluster (primary disconnect) on the breaker, and rigidly mounted silver plated copper stabs within the insulated housing mounted on the compartment wall. The current transfer from vacuum interrupter moving stem to the primary disconnect cluster on the breaker shall be non-sliding type via heavily silver or tin plated flexible copper leaf conductors attached on each end.
2. Each circuit breaker shall be supplied with contact surface erosion (contact wear) indicator that requires no tools or measurements for the checking of the contact surface erosion.
3. Each circuit breaker shall be equipped with high-speed stored energy operating mechanism and shall permit open-close-open (OCO) operating sequence without recharging the closing springs.
4. The breaker front panel shall be removable when the compartment door is open for ease of inspection and maintenance of the mechanism.

5. Each circuit breaker shall be equipped with mechanical operations counter on the front of the breaker to provide record of the number of circuit breaker operations.
 6. Each circuit breaker shall include contacts Open/Close and spring Charged/Discharged status indications on the front of the breaker.
 7. Each circuit breaker shall be supplied with an auxiliary switch with 5 NO and 5 NC contacts. The switch shall be heavy duty, double break type with wipe type contacts. All unused contacts from this switch shall be wired out to terminal blocks for owner's use.
 8. Each circuit breaker shall be supplied with Manual "ON" and "OFF" push buttons located on the front of the circuit breaker for opening and closing the breaker manually, without a need for external control power.
 9. Each circuit breaker shall be electrically operated (EO). Energy required for closing and opening of the circuit breaker shall be provided by charging of springs by an electrical motor. Electrical closing/opening of the circuit breaker shall be accomplished by energizing spring release coil/shunt trip coil. Control voltage required for electrical operation of the breakers shall be derived from a control power transformer mounted within the switchgear and shall be as follows:
 - a. 120 Vac Close and AC Capacitor Trip.
 10. One control circuit cutout device shall be provided and installed in the control compartment of each circuit breaker for control circuit isolation and short circuit protection.
 11. All EO circuit breakers shall also be supplied with a spring charging handle located on the front of the circuit breaker for manually charging closing springs during an emergency or for maintenance. Manual "ON" and "OFF" push buttons shall be located on the front of the circuit breaker for opening and closing the breaker manually.
 12. For EO circuit breakers, provide pad lockable hinged plastic cover to limit access to Manual "OFF" pushbutton and completely prevent access to Manual "ON" pushbutton.
 13. Termination Lugs: Incoming line and feeder cable lugs shall be two-hole compression copper terminals suitable for cables indicated on Drawings.
- B. Overcurrent Protective Trip System:
1. The switchgear manufacturer shall furnish and install, in the metal-enclosed switchgear, the quantity and type of overcurrent protective trip systems and current sensors or protection relays and current transformers as indicated on the drawings and described hereinafter in this specification.
 2. For feeder breakers, provide microprocessor based three-phase and ground overcurrent protection trip system (Eaton type Digitrip 520MCV or equivalent).
 - a. The three-phase and ground overcurrent protection trip system shall consist of Eaton Digitrip 520V or equivalent trip unit, Type-V or equivalent current sensors and matching rating plug for the trip unit, and mechanical trip actuator. The trip unit shall be UL recognized, CSA approved, and carry CE mark.

- b. The mechanical trip actuator assembly and the trip unit shall be installed on the circuit breaker. The trip unit shall be front accessible. The current sensors shall be installed over insulated bushings, one in each phase, in the primary circuit. The assembly of the bushings and current sensors shall withstand rated impulse voltage of the assembly. Each trip unit shall have rating plug installed that is matched to the associated current sensor rating. Provide an additional rating label on the back surface of the compartment door as a reference to indicate the current sensor and rating plug ratings used for primary circuit associated with that compartment.
- c. The current sensor rating for each circuit shall be as indicated on the drawings or specified hereinafter in this specification. The current sensors produce a secondary output current proportional to the load current. The current sensors and rating plug defines the maximum continuous current rating of the circuit breaker (In). The trip unit shall be self-powered from the current flowing in the secondary of the current sensors, and shall continuously analyze the secondary current signals and, when preset current levels and time delay settings are exceeded, send an initiating trip signal to the trip actuator of the circuit breaker. The trip actuator shall cause tripping of the circuit breaker by providing the required mechanical force for the tripping. The circuit breaker mechanism shall automatically reset the trip actuator each time the circuit breaker opens.
- d. The trip unit shall provide ANSI 50/51 protection functions for each of the (3) phases, and 50/51N or 50/51G protection function for ground as shown on the drawings or as determined by the coordination study. The trip unit shall be microprocessor based that operates from secondary output of current sensors and provide true RMS sensing of each phase and ground, and suitable for application to either 50 or 60 Hz systems. The ground protection shall be capable of being utilized in residual scheme, zero sequence scheme, or deactivated.
- e. The phase and ground time-overcurrent response curves shall have following characteristics:
 - 1) Phase Long Delay: I2t
 - 2) Phase Short Delay: FLAT or I2t (selectable)
 - 3) Phase Instantaneous: FLAT
 - 4) Ground Overcurrent: FLAT or I2t (selectable)
 - 5) Phase Long Delay protection shall have memory feature, when enabled, shall cause breaker to trip in progressively shorter time if the circuit breaker trips and recloses on repeated overload conditions. The memory feature shall reset when at least 10 minutes have elapsed between the overloads.
 - 6) The sensing current for Ground protection shall be derived from the residual connections of the phase sensors or a separate Eaton Type-V or equivalent zero sequence sensor as indicated on the drawings or specified herein after in this specification.

- f. Zone Interlocking
 - 1) The Phase Short Delay time overcurrent and Ground time overcurrent protection functions shall be capable of being zone interlocked between two or more trip units, to provide the fastest possible tripping for faults within the zone of protection of the circuit breaker and yet also provide positive coordination among all breakers in the system to limit power outage to only the affected part of the system. Zone Interlocking wiring shall be provided when indicated on the drawings. When Zone Interlocking is employed, a fault within the zone of protection of the circuit breaker shall cause the trip unit to simultaneously: trip the affected circuit breaker immediately and send a signal to upstream trip unit to restrain from tripping immediately. The restraining signal shall cause the upstream trip units to follow their set coordination times, so that the service is only minimally disrupted while the fault is cleared in the shortest possible time.
 - g. The trip unit shall be provided with a green LED (for unit status) that blinks approximately once every second to indicate that the trip unit is energized and operating properly. The trip unit shall be energized (become self-powered) once the 3-phase load current through the circuit breaker exceeds approximately 10-12% of the current sensor rating or 1-phase load current exceeds approximately 30% of the current sensor rating.
 - h. The trip unit shall be provided with representation of the time-current curve depicted on the faceplate of the unit that indicates the protection functions. The trip unit shall have battery backed-up LEDs strategically located in the related segment of the time-current representation to indicate mode of trip following an automatic trip operation. A reset/battery test button shall be provided to turn off the LEDs and reset the trip unit after an automatic trip. All protection functions of the unit shall be independent of the battery. The battery shall be used for automatic trip indication only. The battery shall be 3 volt, 1/3N lithium cell. It shall be front accessible and shall not affect operation of the trip unit or its protection function when installing/removing even when circuit breaker is in service.
 - i. The trip unit shall have a test access port, protected by removable plexiglass cover, for interface with a handheld tester capable of testing trip elements of the trip unit, and mechanical trip assembly of the circuit breaker.
 - j. Provide one handheld tester for each type of circuit breaker trip unit supplied.
- 3. For main and generator breakers, provide microprocessor based three-phase and ground overcurrent and voltage protection trip system with metering and on-board display capability (Eaton type Digitrip 1150V or equivalent).
 - a. The three-phase and ground overcurrent and voltage protection trip system shall consist of Eaton Digitrip 1150V or equivalent trip unit, Type-V or equivalent current sensors and matching rating plug for the trip unit, and mechanical trip actuator. The trip unit shall be UL recognized, CSA approved, and carry CE mark.

- b. The mechanical trip actuator assembly and the trip unit shall be installed on the circuit breaker. The trip unit shall be front accessible. The current sensors shall be installed over insulated bushings, one in each phase, in the primary circuit. The assembly of the bushings and current sensors shall withstand rated impulse voltage of the assembly. Each trip unit shall have rating plug installed that is matched to the associated current sensor rating. Provide an additional rating label on the back surface of the compartment door as a reference to indicate the current sensor and rating plug ratings used for primary circuit associated with that compartment.
- c. The current sensor rating for each circuit shall be as indicated on the drawings or specified hereinafter in this specification. The current sensors produce a secondary output current proportional to the load current. The current sensors and rating plug defines the maximum continuous current rating of the circuit breaker (In). The overcurrent protection functions of the trip unit shall be self-powered from the current flowing in the secondary of the current sensors. The trip unit shall continuously analyze the secondary current signals and, when preset current levels and time delay settings are exceeded, send an initiating trip signal to the trip actuator of the circuit breaker. The trip actuator shall cause tripping of the circuit breaker by providing the required mechanical force for the tripping. The circuit breaker mechanism shall automatically reset the trip actuator each time the circuit breaker opens.
- d. The trip unit shall be microprocessor based that operates from secondary output of current sensors and external voltage transformers and provide true RMS sensing of each phase and ground, and suitable for application to either 50 or 60 Hz systems. The ground protection shall be capable of being utilized in residual scheme, zero sequence scheme, or deactivated. The overcurrent protection functions of the trip unit shall be self-powered from the current flowing in the secondary of the current sensors. The auxiliary power required for voltage and frequency related protection and alarm functions shall be 120 +/- 10%, and shall be derived from UPS module powered from a CPT within the switchgear lineup. The trip unit shall provide following ANSI/IEEE protection functions:
- 1) 51/50 (time and instantaneous overcurrent) for each of the (3) phases
 - 2) 51/50N or 51/50G (time and instantaneous overcurrent) for ground
 - 3) 37 (phase loss, with adjustable time delay)
 - 4) 46 (current unbalance, with adjustable time delay)
 - 5) 27 (3-phase undervoltage, with adjustable time delay)
 - 6) 59 (3-phase overvoltage, with adjustable time delay)
 - 7) 81U (underfrequency, with adjustable time delay)
 - 8) 81O (overfrequency, with adjustable time delay)
 - 9) 47 (voltage unbalance, with adjustable time delay)
 - 10) 32 (reverse power, with adjustable time delay)

- e. Phase Long Delay protection shall have memory feature, when enabled, shall cause breaker to trip in progressively shorter time if the circuit breaker trips and recloses on repeated overload conditions. The memory feature shall reset when at least 10 minutes have elapsed between the overloads. The trip unit shall have ground fault memory to protect loads in the event of a sputtering arc to ground. The ground protection shall remember the sputtering ground for up to ten (10) times the ground fault time setting to allow detection of the sputtering arcing faults. After the expiration of the memory time, the unit shall reset automatically. The sensing current for Ground protection shall be derived from the residual connections of the phase sensors or a separate Eaton Type-V or equivalent zero sequence sensor as indicated on the drawings or specified herein after in this specification. The phase and ground time-overcurrent response curves shall have selectable characteristics as follows:
 - 1) Phase Long Delay: I2t, I4t, IEEE Moderately Inverse, Very Inverse, or Extremely Inverse
 - 2) Phase Short Delay: FLAT or I2t
 - 3) Phase Instantaneous: FLAT or I2t
 - 4) Ground Overcurrent: FLAT or I2t
- f. Trip unit shall accept secondary output of 110 or 120 V, derived from a set of external primary voltage transformers, connected in two line-to-line or three line-to-ground configurations. The primary voltage transformer ratio shall be programmable for correct display of measured primary voltages, power, and energy values.
- g. The trip unit shall have a built-in 24-character alpha-numeric LED display to allow programming and viewing of settings, menus, trip and alarm logs, and real time metering data. All settings shall be programmable through use of appropriate buttons located on the front of the unit.
- h. Trip unit shall be capable of displaying following meter values:
 - 1) Individual phase and ground currents in RMS amperes, real time
 - 2) Individual phase and ground currents in avg RMS ampere (5 min average)
 - 3) Individual phase and ground currents, maximum and minimum (since last reset)
 - 4) Line-to-Line Voltages – Vab, Vbc, Vca
 - 5) Forward/Reverse kW, kW Demand, and Max kW Demand
 - 6) KVA, kVA Demand, and Max kVA Demand
 - 7) Watt and VA demand, maximum W and VA demand
 - 8) Forward/Reverse kWh
 - 9) KVAh
 - 10) Total Harmonic Distortion for each phase current

- 11) Individual harmonic currents up through 27th harmonic for each phase
- 12) Power factor, minimum, maximum
- 13) Frequency
- 14) Circuit breaker operations count
- 15) Metering accuracy shall be minimum:
 - a) +/- 1% of full-scale (I_n) for currents for currents in the range of 5 to 100% of (I_n)
 - b) +/- 3% of full-scale for voltages (full-scale is equal to VT primary voltage)
 - c) +/- 4% of full scale for power and energy readings
- i. The trip unit shall be capable of communication to a remote master computer. The communication shall include display of monitored values, trip/alarm events, remote open/close controls, and waveform capture and display.
- j. Provide Modbus RTU communications board for RS-485 serial communication with remote Modbus master.
- k. The trip unit shall have programmable output contacts, designated as Relay contacts A, B, and C. The Relay contact A can be programmed and activated for one or more trip or alarm conditions or it can be programmed for use as a pulse initiator for either kWh or kVAh functions to transmit kWh or kVAh pulses to an external counter. The Relay contact B can be programmed and activated for one or more trip conditions for use as blocking relay to prevent closing of the circuit breaker after a trip until the trip unit is reset. The Relay contact C can be programmed and activated and latched for one or more trip conditions.
- l. Zone Interlocking
 - 1) The Phase Short Delay time overcurrent and Ground time overcurrent protection functions shall be capable of being zone interlocked between two or more trip units, to provide the fastest possible tripping for faults within the zone of protection of the circuit breaker and yet also provide positive coordination among all breakers in the system to limit power outage to only the affected part of the system. Zone Interlocking wiring shall be provided when indicated on the drawings or specified herein after in this specification. When Zone Interlocking is employed, a fault within the zone of protection of the circuit breaker shall cause the trip unit to simultaneously: trip the affected circuit breaker immediately and send a signal to upstream trip unit to restrain from tripping immediately. The restraining signal shall cause the upstream trip units to follow their set coordination times, so that the service is only minimally disrupted while the fault is cleared in the shortest possible time.
- m. The trip unit shall be provided with a green LED (for unit status) that blinks approximately once every second to indicate that the trip unit is energized and operating properly. The overcurrent functions of the trip unit shall become self-powered once the 3-phase load current through the circuit breaker exceeds approximately 10-12% of the current sensor rating or 1-phase load current exceeds approximately 30% of the current sensor rating.

- n. The trip unit shall be provided with representation of the time-current curve depicted on the faceplate of the unit that indicates the protection functions. The trip unit shall have battery backed-up LEDs strategically located in the related segment of the time-current representation to indicate mode of trip following an automatic trip operation. A battery test button shall be provided to confirm battery status and to reset the LEDs. All protection functions of the unit shall be independent of the battery. The battery shall be used for trip indication LEDs only. The battery shall be 3 volt, 1/3N lithium cell. It shall be front accessible and shall not affect operation of the trip unit or its protection function when installing/removing even when circuit breaker is in service.
- o. The trip unit shall provide following data through its front panel display to help plan inspection and maintenance schedules of the circuit breaker and circuit it is protecting:
 - 1) Total number of instantaneous and short delay trip operations by the circuit breaker since last reset
 - 2) Total number of overloads (long delay trips) and ground fault trips since last reset
 - 3) Total number of Close Operations by the circuit breaker since last reset
 - 4) The last time the circuit breaker was operated (Opened or Closed or Tripped) with time and date
 - 5) Maximum chip temperature in degrees C as seen by the trip unit
- p. The trip unit shall have a test access port, protected by removable plexiglass cover, for interface with a handheld tester capable of testing trip elements of the trip unit, and mechanical trip assembly of the circuit breaker.

C. Auxiliary Components:

- 1. Voltage transformers shall be supplied as shown on the one-line diagram.
- 2. The voltage transformers shall be mounted on tilt-out trunnions or drawout drawer assemblies and equipped with current limiting primary fuses. In the withdrawn position, the fuses and the potential transformers shall be disconnected and grounded to permit safe inspection and/or replacement of the fuses. The trunnion frame shall be connected to the ground by a flexible copper cable that is attached directly to the frame. The mechanism shall be arranged so that full access to potential transformers or fuses cannot be accomplished until they are disconnected from high voltage and grounded. Live parts shall be isolated when the voltage transformers are in the withdrawn position to prevent accidental contact by operating or maintenance personnel. Stationary contacts shall be silver plated copper and mounted on porcelain or glass polyester supports. Cables connected to voltage transformer primaries shall be rated for the full voltage and BIL rating of the switchgear.
- 3. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer can be withdrawn.
- 4. Provide lightning arrestors, station class, 3 KV on line side of medium-voltage metal enclosed switchgear or incoming breaker.

2.05 AUTOMATIC TRANSFER CONTROL – TWO BREAKER AUTOMATIC TRANSFER CONTROL WITH COMMON LOAD BUS

- A. Furnish, where shown on the drawings, a switchgear assembly with microprocessor-based automatic transfer control system for two (2) main breakers (utility and generator) with a common load bus. The system shall consist of the two (2) breakers with electrical operators as herein specified, and an integrated microprocessor-based automatic transfer control system containing sensing devices, low voltage logic control, and auxiliary equipment, as indicated on the drawings and specified here. The automatic transfer control system, when placed in the “automatic” mode, shall automatically transfer the load bus circuit to the alternate power source upon failure of the preferred source.
- B. The basic sequence of operation based upon one preferred normally energized utility source and an emergency source shall be as follows. Normal operation shall be with the preferred utility source breaker closed and standby generator breaker open. Upon detection of an undervoltage to the line side of the preferred main breaker and after a field adjustable time delay, that main breaker shall open, and a start signal shall be sent to the generator. After an acceptable voltage and frequency from the emergency source has been proven and an additional field adjustable time delay, the standby generator breaker shall close restoring power to the facility. Controller shall perform a phase sequence check on the standby power source prior to transfer. Upon restoration of voltage to the line side of the preferred utility breaker and after a field adjustable time delay the standby main breaker shall open and after a field adjustable time delay the preferred main breaker shall close. The controller shall then enter an adjustable time delay period for engine cool down.
- C. The logic of the transfer shall function via a microprocessor controller equal to Eaton ATC-900. The set points shall be field adjustable without the use of special tools. LED lights shall be included on the controller to show:
 - 1. Normal Source Available
 - 2. Emergency Source Available
 - 3. Normal Source Connected
 - 4. Emergency Source Connected
 - 5. Load Energized.
- D. A digital readout shall display each option as it is functioning. Readouts shall display actual line-to-line voltage, line frequency and timers. When timers are functioning, the microprocessor shall display the timer counting down. All set points shall be re-programmed from the front panel of the controller when it is in the program mode. In addition, the controller shall display date, time and reason of last 16 transfers, set points of timers, voltage pickup and dropout set points. A communications port shall be provided for communication to an external Power Monitoring System or other system.
- E. The transfer system shall include the following:
 - 1. A time delay transfer from the normal power source to the standby power source and from the standby power source to the normal source, forcing a neutral position to ensure the load voltage has decayed before reconnecting to the source from which the load is to be fed (0 seconds to 30 minutes).
 - 2. A time delay to override a momentary power outage or voltage fluctuation (0 seconds to 120 seconds).

3. A time delay for transferring from the standby power source to the normal power source (0 seconds to 30 minutes).
 4. A Form C relay contact that changes state when the power is available on the normal source.
 5. A Form C relay contact that changes state when the power is available on the standby source.
 6. Two Form C relay contacts for start commands to generator.
 7. A preferred source selection (Source 1 or Source 2, or none).
 8. Electrical Interlocking shall prevent paralleling of two sources in manual mode.
 9. Generator Exerciser Feature. This feature shall provide for the automatic testing of the generator at a pre-selected weekly interval. The day of the week, hour, and minute of exercising shall be adjustable. The type of test, whether a load transfer or just an engine test, shall also be adjustable.
- F. Two (2) sets of three-phase "line side" voltage transformers with primary fuses and secondary supplementary protectors as shown on the one-line diagram.
- G. The automatic transfer system shall contain:
1. One (1) selector switch with automatic and manual positions.
 2. One (1) open-close control switch for manual electrical operation of each controlled breaker.
 3. One (1) pushbutton to initiate manual retransfer to preferred source when the IQ Transfer Controller is functioning in automatic mode and programmed for manual retransfer.
 4. One RS-485 serial connection for Modbus RTU communication to supervisory system. Information available over Modbus RTU shall be equivalent to that provided by an Eaton ATC-900.

2.06 IDENTIFICATION

- A. Provide control wiring and internal device identification for each compartment, including:
1. Identify all control conductors with permanent type wire markers. Identify each wire by a unique number and attach to wire at each termination point.
 2. Identify all control devices with permanent type markers. Identify each device by a unique number and attach to each device.
 3. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.07 FINISHING

- A. Thoroughly clean medium-voltage metal enclosed switchgear metal surfaces, provide surface preparation in accordance with paint manufacturer's recommendations, and provide one coat of standard primer. Surfaces located indoors shall be given one shop coats of standard finish.

Provide exterior surfaces located outdoors two shop coats of standard finish. Color of finishing coats shall be ANSI No. 61, "gray".

2.08 SOURCE QUALITY CONTROL

- A. Perform factory tests on equipment prior to shipment, consisting of manufacturer's standard tests, which shall include:
 - 1. Production tests on circuit breakers, medium-voltage metal enclosed switchgear assembly, and components in accordance with ANSI C37. 09.
 - 2. Physical inspection of all components, and wiring checks.
 - 3. Breaker operation, device functional tests, and sequencing of control circuits.
 - 4. Primary, control, and secondary wiring dielectric tests.
 - 5. Independent operation of first two switchgear sections.
 - 6. Testing of automatic transfer switch controller, generator start signals, and automatic switching of main and generator breakers.
 - 7. ZSI functional test.
- B. Medium-voltage switchgear shall be witness tested:
 - 1. Medium-voltage switchgear shall be witness tested at the manufacturer factory before shipping. The CONTRACTOR shall pay all costs for up to two OWNER representatives and one ENGINEER to witness the medium-voltage switchgear manufacturer's test. Dates of test shall be acceptable to the OWNER and be agreed upon in writing at least ten days prior to actual test. Cost shall include provisions for meals, airfare, lodging, miscellaneous items such as parking and tolls.
 - 2. If re-testing is required, all related time and expense costs incurred by the OWNER will be provided by the CONTRACTOR. If tests are not performed on agreed-upon date as a result of the CONTRACTOR'S or medium-voltage switchgear manufacturer's action and the OWNER incurs lost time as a result of this action, associated costs will be deducted from money due to the CONTRACTOR.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
 - 1. Install equipment in accordance with manufacturer's recommendations and instructions.
- B. Coordinate power outages with Owner's Operations.

C. Terminations and Appurtenances:

1. Install terminations, lugs, and required appurtenances to properly terminate power supplies.
2. Install control wiring terminations and appurtenances necessary to complete the installation of control and monitoring devices.

3.03 FIELD QUALITY CONTROL

A. Site Tests

1. Provide field testing and inspection of medium-voltage metal enclosed switchgear. After installation, inspect, adjust, and test switchgear. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Manufacturer's representative shall inform OWNER and ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of OWNER.
2. Perform the following tests and checks before energizing equipment:
 - a. Verify proper installation of medium-voltage metal enclosed switchgear and protective device settings.
 - b. Inspect all mechanical and electrical interlocks and breakers for proper operation.
 - c. Check tightness of bolted connections. Torque to manufacturer's requirements.
 - d. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
 - e. Measure insulation resistance of each circuit breaker pole-to-pole and from pole-to-ground.
 - f. Perform other tests and adjustments recommended by equipment manufacturer.
3. Qualified, factory-trained service representative, from protective device manufacturer shall perform calibration, settings, and programming of actual protective devices provided.
4. Provide acceptance testing of medium-voltage metal enclosed switchgear. Inspect and test each switchgear. Testing and inspection shall be performed by independent testing firm, after completion of field testing specified in Paragraph 3.03.A 1 of this Section.
 - a. Visual and Mechanical Inspection: Inspect each medium-voltage metal enclosed switchgear in accordance with ANSI/NETA ATS, including:
 - 1) Inspect for physical, electrical, and mechanical condition.
 - 2) Check for proper anchorage, required area clearances, physical damage, and proper alignment.
 - 3) Inspect all bolted connections for high resistance.
 - 4) Check electrical and mechanical interlock systems for proper operation.

- 5) Perform mechanical operational tests on each circuit breaker and its operating mechanism.
 - 6) Measure and adjust as required circuit breaker mounting provisions.
 - 7) Inspect protective relay components, check for freedom of movement, proper travel and alignment, and tightness of mounting hardware and plugs.
 - 8) Clean entire switchgear.
- b. Electrical Tests: Perform electrical testing of each medium-voltage metal enclosed switchgear in accordance with ANSI/NETA ATS, including performing:
- 1) Ground-resistance tests.
 - 2) Insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.
 - 3) An over-potential test on each bus section, each phase-to-ground.
 - 4) Insulation-resistance tests on each breaker. Test each pole, phase-to-phase and phase-to-ground.
 - 5) Minimum pickup voltage tests on trip and close coils.
 - 6) Trip each circuit breaker by operating each protective device.
 - 7) Vacuum bottle integrity test across each vacuum bottle with breaker in open position.
 - 8) Contact-resistance test on each breaker.
 - 9) Control and metering wiring performance test.
 - 10) Pickup parameters and timing tests on protective relays.
 - 11) Automatic transfer controller logic with the utility as the preferred source. Confirm start signal to generator and switching of main and generator/emergency breakers.
 - 12) ZSI system configuration and operation.

B. Manufacturer's Services

1. Manufacturer's factory-trained representative shall adjust system to initial settings as specified in Article 3.04 of this Section.
2. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
3. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during correction period specified in the General Conditions and Supplementary Conditions.
4. Replacement parts or equipment installed during correction period shall be equal to or better than original.

5. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of materials and equipment. Training requirements, duration of instruction, and other requirements shall be in accordance with Section 01800, Equipment and System Training.
6. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.04 ADJUSTING

- A. Calibrate, set, and program protective devices, automatic transfer controller, and ZSI system. Coordinate protective devices furnished under this Section and include the proper settings of all devices in accordance with the findings of study specified under Section 16215, Electrical Power Distribution System Studies.

END OF SECTION 16341

SECTION 16349

MEDIUM-VOLTAGE MOTOR STARTERS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install medium-voltage motor starters.

B. Coordination:

1. Coordinate motor starters with driven equipment furnished under other Specification Sections to ensure compatibility of components.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems
3. Section 16075, Identification for Electrical Systems.
4. Section 16215, Electrical Power Distribution System Studies.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
2. NEMA ICS 3, Industrial Control Systems Medium Voltage Controllers.
3. NEMA ICS 6, Industrial Control and Systems Enclosures.
4. NFPA 79, Electrical Standard for Industrial Machinery.
5. UL 347, Medium-Voltage A-C Contractors, Controllers, and Control Centers.
6. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary.
7. ISO 9001, Quality Management Systems, Requirements.
8. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:

- a. Manufacturer shall have experience of manufacturing substantially similar equipment to that required and, upon ENGINEER's request, shall submit documentation of not less than five installations in satisfactory operation.
 - b. Manufacturer shall be ISO 9000, ISO 9001, or ISO 9002-certified for the equipment required.
- 2. Independent Testing Firm:
 - a. Retain an independent testing firm to perform field acceptance testing of the medium-voltage starters installed at the Site. Testing firm shall have experience in inspecting and testing of medium-voltage starters and be a member company of NETA.
- 3. Test Equipment, Calibration and Reporting:
 - a. Test equipment, instrument calibration, and test reports shall be in accordance with ANSI/NETA ATS.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Outline, summary sheets, and equipment schedules.
 - b. Unit control schematics and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
 - c. Three-line diagrams.
 - d. Time current curves for protective devices.
 - e. Components list and nameplate schedule.
 - f. Dimensional information including front view elevation and floor plan.
 - g. Construction details of enclosures with conduit entry locations and connection details between assemblies.
- 2. Product Data:
 - a. Technical specifications with assembly and component ratings.
 - b. Catalog cut sheets.
 - c. Modbus RTP registers for motor controller and motor protection relay variables.
- 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Prior to testing submit operational and protective device settings recommended for this equipment.
 - b. Not less than thirty days prior to scheduled factory testing, submit proposed testing procedures, methods and apparatus.
 - c. Not less than thirty days prior to scheduled field testing, submit proposed testing procedures, methods and apparatus.

B. Informational Submittals: Submit the following:

1. Supplier Instructions:
 - a. Installation instructions.
 - b. Instructions for handling, start-up, and troubleshooting.
2. Source Quality Control Submittals:
 - a. 30 days prior to the witnessed test, the CONTRACTOR shall provide a factory witness test procedure to the ENGINEER and OWNER for review and approval.
 - b. Submit reports of completed factory testing, including procedures used and test results achieved.
3. Field Quality Control Submittals:
 - a. Submit reports of completed field testing, including procedures used and test results achieved.
4. Qualifications Statements:
 - a. Manufacturer: When requested by ENGINEER, submit manufacturer's record of experience including previous similar installations.
 - b. Independent Testing Firm.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Copy of RVSS and Motor Protective Relay setup sheet with all applicable settings, trip, and alarm setup information completed. Include a listing of all programmable soft starter parameters and their settings at Substantial Completion. Highlight settings that have been changed from their default values. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on removable media. Provide any available software and custom configuration files that can be used to directly upload the final settings to the starter in the event of replacement or repair.
 - d. Furnish operation and maintenance manuals per 01782, Operation and Maintenance Data.

D. Maintenance Materials Submittals: Submit the following:

1. Spare parts and Extra Stock Materials:
 - a. Furnish, tag, and box for shipment and long term storage the following spare parts and special tools for each medium-voltage motor starter lineup:

Item	Quantity per Starter Lineup
1) Control fuses	One per each type and size used
2) Power fuses	Two sets for each type and size used
3) Auxiliary control relays	Two, with at least two normally open and two normally closed contacts
4) Control power transformers	Two of each size used
5) Indicating lamps	Two of each model used
6) GE 869 motor protection relay and case	One of each model used

- b. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, the quantity recommended and current unit price.

2. Tools:

- a. Furnish portable lifting device for transporting contactor outside its compartment.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Shipping sections shall be constructed to be shipped by truck, rail, and ship. Indoor sections shall be bolted to skids.
- B. Equipment shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the sections.

PART 2 – PRODUCTS

2.01 EQUIPMENT PERFORMANCE

A. System Description:

1. Provide starters for control of the following motor and starting types in quantities indicated on Drawings.
- a. SCR based solid state reduced voltage starting.
- b. Starter assembly shall have the capability of across-the-line motor starting using the bypass contactor.

B. Performance Criteria:

1. Provide a 4 KV medium-voltage starters lineup designed and tested to comply with the following:
- a. NEMA ICS 3-2.
- b. NFPA 79.
- c. UL 347.
2. Provide medium-voltage starter lineups rated as follows:
- a. 4.16 KV nominal.

- b. Basic Impulse Level (BIL): 60 KV.
- c. Minimum current rating: 180 amperes.
- d. 430 MVA three-phase symmetrical at 5 KV short circuit rating.
- e. Current limiting power fuses for NEMA Class E2 operation.

2.02 MANUFACTURERS

A. Manufacturer: Provide products of one of the following:

- 1. Eaton.
- 2. Rockwell/Allen-Bradley.
- 3. Or approved equal.

2.03 CONSTRUCTION

A. Construction:

- 1. Provide starter lineup arranged in one-high construction.
- 2. Enclosure shall be NEMA 1G metal-enclosed, dead front, front accessible, free standing, dust resistant, and fabricated of code gauge steel. Chemically clean, treat, and finish-coat all metal surfaces with ANSI 49 medium light gray paint.
- 3. Enclosure shall include low-voltage control compartments. Low-voltage control compartment shall be isolated by barriers from higher-voltage area, and mounted on a panel with a separate low-voltage access door. Low-voltage control compartments shall be accessible by sliding panel out of low-voltage control compartment.
- 4. Each RVSS system enclosure shall be fitted with cooling fan(s) as required. Fans shall operate only when the RVSS is running, for a period of time after the RVSS turns off, and when cooling is required for internal components as required by the RVSS Manufacturer.
- 5. Equip enclosure front with nameplates for identification of equipment and operating functions, in accordance with Section 16075, Identification for Electrical Systems.

B. Buses:

- 1. Buses shall be tin-plated copper. Ground bus shall be not less than 1/4-inch by two-inch. Run power and ground buses the length of starter lineup. Each section shall contain a vertical power bus.
- 2. Power bus supports, bus and interconnections shall withstand stresses associated with short-circuit currents up through the maximum rating of the starter lineup.
- 3. Provide ground bus with a 4/0 connector at each end.

2.04 STARTERS AND DEVICES

A. Starters shall be NEMA Class E2. Unless otherwise shown or indicated, starters shall be suitable for full voltage start, three-phase operation.

- 1. Starters carriage shall be fixed-mounted and easily removed. Starters shall have current ratings indicated on the Drawings and shall include:

- a. Isolated vertical line connectors.
 - b. Three-pole, gang-operated line isolating switch assembly with two-direction driven isolating shutter, external operating handle with provisions for padlocking in the off position.
 - c. Solid state, microprocessor controlled, reduced voltage starter.
 - d. Magnetic three-pole vacuum main and bypass contactors. Bypass contactor shall short the SCR power section when the motor reaches full speed.
 - e. Control power transformer, 120-volt secondary, fused on high- and low-voltage sides and sized to operate all auxiliary devices.
 - f. Built-in test circuit to test contactor operation and low voltage pilot circuits from an external 120-volt source with high voltage connections de-energized.
 - g. The vacuum contactor coil controller shall provide a DC operating voltage for the vacuum contactor coils.
 - h. Anti-single phasing protection.
 - i. Interlocks shall include:
 - 1) Prevent compartment door from being opened when the isolating switch is in the on position.
 - 2) Prevent isolating switch from being switched on when compartment door is opened.
 - 3) Prevent isolating switch from being switched when contactor is energized.
2. Reduced-voltage starters shall include the following additional devices:
- a. Solid state SCR power section with adjustable ramp time, (0-200s) initial current (60-600%) and maximum current. (100-800%)
 - b. Magnetic two-pole vacuum input contactor assembly with DC operating coil and interlocks.
 - c. Magnetic two-pole vacuum bypass contactor assembly with DC operating coil and interlocks.

B. Motor monitoring and protection:

- 1. The controller shall provide the following monitoring functions indicated though the built-in LCD display or remotely via the communication port.
 - a. Phase-to-phase supply voltage
 - b. Three-phase line current
 - c. Three-phase power (MW, MWh, power factor)
 - d. Elapsed time
 - e. Motor thermal capacity usage

2. The controller shall provide the following protection and diagnostics features. Motor protection shall be provided during starting and in bypass modes of operation.
 - a. Power loss (with phase indication; pre-start)
 - b. Line fault (with phase indication; pre-start) advising:
 - 1) Shorted silicon controlled rectifier (SCR)
 - 2) Missing load connection
 - c. Line fault (running protection) advising:
 - 1) Power loss
 - 2) Shorted SCR
 - 3) Missing load connection
 - d. Voltage unbalance
 - e. Phase reversal
 - f. Undervoltage
 - g. Overvoltage
 - h. Stall
 - i. Jam
 - j. Overload
 - k. Underload
 - l. Excessive starts/hour
 - m. Open gate (with phase indication)
 - n. Overtemperature (power stack, with phase indication)
 - o. Communication loss
 - p. Motor temperature
3. The controller shall be able to communicate with the pump station SCADA system using Modbus RTU over a serial RS-485 port.
4. Current Transformers: Current transformers shall have relay and metering high accuracy. Transformers shall have mechanical rating equal to the momentary rating and be insulated for full voltage rating of medium-voltage starters.
5. Voltage Transformers: Voltage transformers shall be draw-out type, equipped with current-limiting fuses.

6. Current and voltage transformers shall be wired to front panel mounted test switch. Shorting style switches shall be used for current transformers. Test switch shall be ABB FT style.
7. Control Wiring: Control wiring shall be No. 14 stranded, tinned copper, Type SIS 90 degrees C, rated 600 volts. Terminate wire with crimp type insulated spade terminals or non-insulated ring terminals. Current transformer wiring size shall be No. 12 minimum, and be terminated with ring-type terminals.
8. Control relays, timers, pilot lights, and other devices as shown on the Drawings and as required for proper operation and to achieve the pump control sequence.

C. Motor Protection Relay:

1. Each RVSS assembly shall be provided with a draw-out type, conformal protective coated, motor protection relay (MPR) to provide the protective functions listed below. A multi-function motor management relay, GE Multilin 869 shall provide motor protection, fault diagnostics, power metering and communications functions all integrated into one complete package. Device shall be provided with a 10-year warranty.
 - a. Access to actual values and setpoints shall be accomplished through an illuminated display and associated keypad.
 - b. Protection functions shall include:
 - 1) 12 3-wire PT100 RTD Inputs:
 - a) Motor winding (6).
 - b) Motor bearing (2).
 - c) Pump bearing (2).
 - 2) 4 analog inputs (future vibration use).
 - 3) Motor thermal model consisting of customizable overload curves, unbalance biasing, hot/cold motor compensation and motor cooling time constants.
 - 4) Stall/Jam protection.
 - 5) Undervoltage/Overvoltage Protection.
 - 6) Phase sequence/current unbalance.
 - 7) Phase and Ground Overcurrent.
 - 8) Under/over Frequency.
 - 9) Motor differential protection.
 - 10) Seven 24 V digital inputs.
 - c. Voltage transformer inputs shall be used to provide overvoltage, undervoltage, voltage phase reversal functions.
 - d. A complete on-board digital metering package shall provide accurate metering of amps (plus or minus 1%), volts (plus or minus 1%), watts (plus or minus 2%), VARs (plus or minus 2%), volt-amps (plus or minus 2%), power factor (plus or minus 2%)

and Hertz; peak demand of amps, watts, VARs and volt-amps and temperature of motor windings and motor and pump bearings from RTDs.

- e. Setpoint programming of the MPR shall be available through a front mounted USB interface.
 - f. Current transformers and potential transformers for metering and protective functions shall be furnished.
 - g. Each MPR shall be equipped with output capability. The outputs shall include, in addition to the digital communication capabilities, the following:
 - 1) Ten configurable relay outputs to include motor trip and alarm.
 - 2) 4-20 mA, programmable for motor current, or trip level.
 - h. The MPR shall have a digital communications port which allows communication with a supervisory control system.
 - 1) Software protocol for communication shall be Modbus RTU.
 - 2) Hardware interface shall be serial RS-485.
2. The motor controller shall accept an input signal (dry contact) from the MPR to initiate a RVSS shutdown. See Drawings for relay logic.

2.05 IDENTIFICATION

- A. Provide control wiring and internal device identification for each starter, complying with the following:
 - 1. Identify all control conductors with permanent type wire markers. Identify each wire with a unique number attached to the wire at each termination point.
 - 2. Identify all control devices with permanent type markers. Identify each device by a unique number attached to each device.
 - 3. Numbering system for each wire and control device shall be identified on the wiring diagrams and reflect actual designations used in the Work.

2.06 SOURCE QUALITY CONTROL

- A. Tests and Inspections: Perform factory tests on equipment prior to shipment. Tests shall consist of manufacturer's standard tests, and shall include not less than the following:
 - 1. Physical inspection, checking of all components, and wiring checks.
 - 2. Starter operation, device functional tests, and sequencing of control circuits. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
 - 3. Primary, control, and secondary wiring dielectric tests.
 - 4. Instruments, meters, protective devices, and associated equipment shall be functionally tested by applying the specified control signals, current and/or voltages.
- B. Medium-voltage RVSSs shall be witness tested:

1. Medium-voltage motor starters shall be witness tested at the manufacturer factory before shipping. The CONTRACTOR shall pay all costs for up to two OWNER representatives and one ENGINEER to witness the motor starter manufacturer's test of one job RVSS. Dates of tests shall be acceptable to the OWNER and be agreed upon in writing at least ten days prior to actual test. Cost shall include provisions for meals, airfare, lodging, miscellaneous items such as parking and tolls.
2. If re-testing is required, all related time and expense costs incurred by the OWNER will be provided by the CONTRACTOR. If tests are not performed on agreed-upon date as a result of the CONTRACTOR'S or RVSS manufacturer's action and the OWNER incurs lost time as a result of this action, associated costs will be deducted from money due to the CONTRACTOR.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install equipment on concrete bases in accordance with manufacturer's recommendations and instructions, the Contract Documents, and Laws and Regulations.
- B. Provide all terminations, lugs, and appurtenances necessary to properly terminate power supplies.
- C. Provide control wiring terminations and appurtenances necessary to complete the installation of control and monitoring devices.

3.03 FIELD QUALITY CONTROL

- A. Site Tests:
 1. Perform field testing and inspection of medium-voltage motor starters. After installation, inspect, adjust, and test each medium-voltage motor starter. Testing and inspection shall be in accordance with the manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Advise ENGINEER when the equipment is correctly installed as indicated by the manufacturer's representative. Do not energize equipment without OWNER's permission.
 2. Perform the following tests and checks before energizing equipment:
 - a. Verify proper installation of medium-voltage starters and fuse ratings.
 - b. Inspect all mechanical and electrical interlocks and starters for proper operation.
 - c. Check tightness of bolted connections, and torque to manufacturer's requirements.
 - d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
 - e. Measure insulation resistance of each switch and starter, pole-to-pole and from pole-to-ground.

- f. Perform other tests and adjustments recommended by equipment manufacturer.
- 3. Qualified, factory-trained service representative from manufacturer shall perform calibration, setting, and programming of motor protections based on powered motor. Setup shall also include temperature monitor configuration and settings of alarm and trip setpoints.
- 4. Perform acceptance testing of medium-voltage motor starters. Testing shall be performed by financially independent NETA accredited organization functioning as an unbiased testing authority. Testing firm shall inspect and test each medium-voltage motor starter, after completion of field testing specified in Paragraph 3.03.A.2 of this Section, as follows:
 - a. Visual and Mechanical Inspection: Perform inspection of each medium-voltage motor starter in accordance with the ANSI/NETA ATS, including:
 - 1) Inspect for physical, electrical, and mechanical condition.
 - 2) Check for proper anchorage, required area clearances, physical damage, and proper alignment.
 - 3) Inspect all bolt connections for high resistance.
 - 4) Check electrical and mechanical interlock systems for proper operation.
 - 5) Perform mechanical operation tests on each starter.
 - 6) Inspect protective relay components, check for freedom of movement, proper travel, and alignment, and tightness of mounting hardware and plugs.
 - b. Electrical Tests: Perform electrical testing of each medium-voltage motor starter in accordance with ANSI/NETA ATS, including performing:
 - 1) Ground-resistance tests.
 - 2) Insulation-resistance tests on each bus section, and starter phase-to-phase and phase-to-ground.
 - 3) Over-potential test on each bus section, each phase-to-ground.
 - 4) Adjust and test motor starting controls and protective units.
 - 5) Confirm temperature monitor alarm and trip setpoints and output relay operation.
 - 6) Provide all testing equipment and services for testing the equipment specified.

B. Manufacturer's Services:

- 1. Provide a qualified, factory-trained service person to perform the following:
 - a. Instruct CONTRACTOR in installing equipment.
 - b. Perform motor starting calculations using data from approved equipment specific to the project to determine appropriate operational and protective settings of the starter controller and motor protective device.
 - c. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.

- d. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
- 2. Manufacturer's service person shall make visits to the Site as follows:
 - a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
 - b. Second visit shall be for checking completed installation, start-up of system; adjusting in accordance with Article 3.04 of this Section; and performing field testing. Minimum number of hours on-Site: 16 hours. Representative shall operate and test the system in the presence of ENGINEER and verify that the equipment complies with the Contract Documents.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and other requirements shall be in accordance with Section 01800, Equipment and System Training.
 - 3) Number of hours on-Site shall be in accordance with Section 01800, Equipment and System Training.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - e. Furnish services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of OWNER's request during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
- 3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.04 ADJUSTING

- A. Calibrate, set, and program motor relays and motor protective devices. Coordinate the protective devices furnished under this Section and include proper settings of all devices per the study specified in Section 16215, Electrical Power Distribution System Studies.
- B. Set control devices as required to properly operate with the driven equipment and auxiliary equipment.

END OF SECTION 16349

SECTION 16423

MOTOR CONTROL CENTERS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install motor control centers.

B. Coordination:

1. To properly size circuit breakers, starters, and control power transformers, obtain motor nameplate data on equipment being furnished under this and other contracts as required.
2. To properly size control power transformers, obtain data on motor space heater and other accessories.
3. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before motor control center Work.

C. Related Sections:

1. Section 01330, Submittals.
2. Section 01782, Operation and Maintenance Data.
3. Section 16075, Identification for Electrical Systems.
4. Section 16144, Control Stations.
5. Section 16215, Electrical Power Distribution System Studies.
6. Section 16282, Surge Protective Devices.
7. Section 16442, Panelboards.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/IEEE C37.2, Electrical Power System Device Function Numbers and Contact Designations.
2. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
3. NEMA ICS 18, Motor Control Centers.
4. NEMA ICS 1, Industrial Controls and Systems: General Requirements.
5. UL 845, Motor Control Centers.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have not less than five years experience of producing equipment substantially similar to that required and shall be able to submit documentation of not less than five installations in satisfactory operation for at least five years each.
2. Independent Field Testing Firm:
 - a. Retain an independent testing firm to perform field acceptance testing of motor control centers.
 - b. Testing firm and its assigned personnel shall be experienced in inspecting and testing motor control centers.
 - c. Testing firm shall be a member company of NETA.

B. Regulatory Requirements: Comply with the following:

1. NEC Article 430, Motors, Motor Circuits, and Controllers.

1.04 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Outline and summary sheets with schedules of equipment in each unit.
 - b. One-line diagrams indicating circuit breaker sizes, bus rating, motor controller ratings, and other pertinent information to demonstrate compliance with the Contract Documents.
 - c. Unit control schematic and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
2. Product Data:
 - a. Manufacturer specifications, cut sheets, dimensions, and technical data for all components, materials, and equipment proposed for use.
3. Testing Plans, Procedures, and Testing Limitations:
 - a. Not less than 30 days prior to actual factory testing, submit proposed testing methods, procedures, and apparatus.
 - b. Not less than 30 days prior to actual field testing, submit proposed testing methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:

1. Supplier Instructions:
 - a. Instructions for shipping, storing and protecting, and handling the materials and equipment.

- b. Installation data for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
 - c. Instructions for start-up and troubleshooting.
 - 2. Source Quality Control Submittals:
 - a. Reports of completed factory testing, including procedures used and test results.
 - 3. Site Quality Control Submittals:
 - a. Reports of completed field testing, including procedures used and test results.
 - 4. Supplier Reports:
 - a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 - 5. Qualifications Statements:
 - a. Independent testing firm.
 - b. Manufacturer, when requested by ENGINEER.
- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
 - c. Comply with Section 01782, Operation and Maintenance Data.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts:
 - a. Furnish, tag, and box for shipment and long-term storage the following spare parts and special tools for each motor control center lineup furnished:

Item	Quantity per Switchgear Lineup Furnished
1) Starters and feeder breakers	Quantities and sizes as shown
2) Fuses	Six of each type and size used
3) Auxiliary control relays	Two, with at least two normally open and two normally closed contacts
4) Control power transformers	Two of each size used
5) Indicating lamps	One of each model used
6) Covers for indicating lamps	Two of each color used
7) Starters: Contact kits for Size 1 motor starter	One set of each size used.
8) Starters: Contact kits for Size 2, Size 3, and Size 4 motor starters	One set of each size used

- b. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, the quantity recommended and current unit price.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:

1. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.
 - c. Indoor containers shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
 - d. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
3. Handling:
 - a. Lift, roll or jack motor control center equipment into locations shown.
 - b. Motor control centers shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for placement on rollers using jacks to raise and lower the groups.

B. Storage and Protection:

1. Store motor control center equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Provide equipment by one of the following:

1. General Electric Company.
2. Schneider Electric/Square D Company.
3. Eaton/Cutler-Hammer.
4. Allen-Bradley
5. Or equal.

2.02 MATERIALS

A. General: Motor control center lineups shall comply with NEMA ICS 18 and be provided as shown with the following ratings:

1. Service: Voltage rating and number of wires shall be as shown or indicated on the Drawings. Motor control center shall operate from a three-phase, 60 Hertz system.
2. Wiring: NEMA Class II, Type B.
3. Enclosure: NEMA 12.
4. Interrupting Capacity Rating: Motor control center shall have an interrupting capacity rating as shown or indicated on the Drawings. Devices shall be suitable for minimum rating indicated.
5. Motor control center lineups shall be UL-rated as suitable for service entrance where shown or indicated on the Drawings and as required.

B. Construction: Provide equipment with the following:

1. Totally-enclosed structure, dead front, consisting of nominal 20-inch deep, 20-inch wide, 7.5-foot high vertical sections bolted together to form a unit assembly.
2. Vertical sections shall have side sheets extending the full height and depth of section.
3. Removable lifting angles for each shipping section.
4. Two removable floor sills for mounting.
5. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.
 - a. Wireway openings between sections shall have rounded corners and rolled edges.
6. Isolated vertical wireways with cable supports, accessible through hinged doors, for each vertical section.
 - a. Wireway shall be separate from each compartment and remain intact when compartment is removed.

7. All-metal non-conducting parts electrically continuous.
8. Comply with NEMA ICS 18.
9. MCC structure and field conduit entry locations shall be designed to match existing conduit connection connections points without field modifications to the structure.

C. Bus System:

1. Rating: Bus bracing and bus current capacities as shown or indicated on the Drawings.
2. Bus bars shall be tin-plated, copper-rated, and comply with UL heat rise standards.
3. Bus bar connections shall be easily accessible with simple tools.
4. Main Horizontal Bus:
 - a. Continuous, edge-mounted, and isolated from wireways and working areas.
 - b. Mount the bus in vertical center of motor control center to provide easy access and even heat distribution.
 - c. Bus shall be supported, braced, and isolated by high-strength, non-tracking, FRP material.
5. Vertical Bus:
 - a. Continuous, and isolated by glass polyester barrier.
 - b. Rated for 300 amperes continuous minimum, and at least equal to full-load rating of all installed units in the associated stack.
6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity as required.
7. Neutral Bus: Insulated, continuous through control center for four-wire services, drilled with lugs of appropriate capacity as required.

D. Unit Compartments:

1. Provide individual front door for each unit compartment. Fasten door to stationary structure, instead of the unit itself, so that door can be closed when unit is removed.
2. Starter and feeder unit doors interlocked mechanically with unit disconnect device to prevent unintentional opening of door while energized and unintentional application of power while door is open, with provisions for releasing interlock for intentional access and application of power.
3. Padlocking arrangement permitting locking disconnect device in the "OFF" position with at least three padlocks with door closed or open. Equip unit disconnect devices located in the top compartment, compartment sized 12 inches or higher, with extender handle complying with UL 845. Extender handle shall allow disconnect operating handle to be located above NEC's height limitation of six-feet, seven-inches above floor.

4. Equip compartments as shown or indicated on the Drawings:
 - a. Blank compartments, unused space, and compartments shown or indicated on the Drawings as "SPACE" shall have bus covers and be complete with necessary hardware for future installation of a plug-in unit.
 - b. Provide shutters for each compartment that automatically open when unit is inserted and automatically close when unit is removed.
5. Provide wiring and device identification:
 - a. Identify compartment doors, devices, and field wiring in accordance with Section 16075, Identification for Electrical Systems.
 - b. Identify internal control conductors with permanent wire markers. Each wire shall be identified by a unique number attached to wire at each termination point.
 - c. Identify internal control devices with permanent markers. Each device shall be identified by a unique number attached to each device.
 - d. Numbering system for each wire and control device shall be identified on the wiring diagrams in the Shop Drawings and shall reflect the actual designations used in the Work.
6. NEMA 1 minimum motor starter size. Starter units completely draw out type in Sizes 1 and 2 and draw out type after disconnecting power leads only in Sizes 3 and 4.
7. Motor starters shall be NEMA-rated and include magnetic contactor, with encapsulated magnet coils. Wound coils are unacceptable. Control shall be 120 VAC unless indicated otherwise.
 - a. Starters shall be full-voltage non-reversing unless shown or indicated otherwise on the Drawings.
8. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with the following:
 - a. Electronic Overload Relays: Relays shall be electronic type. Electronic relays shall be multi-function, adjustable, current sensing, type, and include overload, phase-unbalance, phase-loss, and equipment type ground fault in one package.
 - b. Each overload relay shall be manual reset type and shall include provisions for resetting by an insulating button on front of starter unit door.
 - c. Each overload relay shall include a normally-open auxiliary contact for remote alarm purposes.
 - d. Size each overload relay for full-load amperes and service factor of actual motors installed.
9. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100 VA minimum, Class A insulation, two primary fuses, 120-volt secondary, one secondary fuse, and the other secondary leg grounded.
10. Motor horsepower shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.

11. Auxiliary contacts, relays, timers as required for specified control functions and those shown on Drawings.
12. Starter devices, including spare contacts, shall be wired to numbered terminal blocks.
13. Terminal blocks for field connections to unit compartments shall be plug-in/pull-apart type. Terminals shall be fully accessible from the front. Terminals shall be mounted near the front of vertical wireway.
14. Control devices shall be 600-volt heavy duty, NEMA A600. Relays shall have convertible contacts. Switches and indicating lights shall comply with Section 16144, Control Stations.
15. Feeder Circuit Breakers: Thermal magnetic type.
 - a. Circuit breakers of 100-amp frame or less shall be mounted in a dual mount compartment (two breakers in one space factor) or shall mount in one-half space factor, unless otherwise shown or indicated on the Drawings.
16. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors.
17. Provide the following diagrams and tables inside of door for each compartment:
 - a. Elementary wiring diagram.
 - b. Table of overload heater sizes with correct heater highlighted.
 - c. Table of motor circuit protector settings with correct setting highlighted.
18. Provide integral panelboard in accordance with Section 16442, Panelboards where shown or indicated on the Drawings.

2.03 SURGE PROTECTIVE DEVICES

- A. Provide a surge protective device in accordance with Section 16282, Surge Protective Devices, for each motor control center bus shown on the Drawings. Surge protective devices shall be included and factory-mounted within the motor control center by motor control center manufacturer. Surge protective device monitoring and display shall be visible from the motor control center front.

2.04 SOURCE QUALITY CONTROL

- A. Prior to shipping, perform factory tests on motor control centers. Tests shall include manufacturer's standard tests and the following:
 1. Physical inspection and checking of components.
 2. Mechanical operation and device functionality tests.
 3. Primary, control, and secondary wiring hi-pot tests.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install materials and equipment at locations shown or indicated on the Drawings. Install equipment on concrete bases in accordance with the Contract Documents and manufacturer's recommendations and instructions.
- B. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between motor control center and wall for corrosion protection. Trim board neatly within outline of motor control center.
- C. Openings in top or side of motor control centers for other than conduit entrance are not allowed. Adapt existing conduits as required for connection to the motor control center.
- D. Bundle cable circuits together within enclosures and identify with durable tag secured to cabling twine.
- E. Set motor circuit protectors at lowest setting that allows motor starting without nuisance tripping.
- F. Verify that wiring diagrams on inside of door of each compartment reflect the circuitry actually provided and that correct overload heater size and motor circuit protector setting are noted.
- G. Install in conformance with manufacturer's recommendations, Laws and Regulations, and the Contract Documents.
- H. Connections to existing facilities shall be in accordance with Division 1.

3.03 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Perform field testing and inspection of motor control centers. Inspect and test each motor control center after installation. Testing and inspection shall be in accordance with the manufacturer's recommendations and the Contract Documents, and be performed by manufacturer's factory-trained representative, Inform OWNER and ENGINEER when equipment is correctly installed, prior to testing. Do not energize equipment without permission of OWNER.
 - 2. Test Equipment, Calibration and Reporting: All test equipment, instrument calibration and test reports shall be in accordance with ANSI/NETA ATS.
 - 3. Perform the following minimum tests and checks before energizing equipment:
 - a. Verify all overload and device settings.
 - b. Inspect mechanical and electrical interlocks and controls for proper operation.
 - c. Check tightness of bolted connections.
 - d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
 - e. Measure insulation resistance of each starter, phase-to-phase and phase-to-ground.
 - f. Measure insulation resistance of each control circuit with respect to ground.
 - g. Perform other tests recommended by equipment manufacturer.

4. Perform acceptance testing of motor control centers. Inspect and test each motor control center. Testing and inspection shall be performed by the independent testing firm, after completion of field testing specified in Paragraph 3.03.A.3 of this Section.
 - a. Visual and Mechanical Inspection: Perform inspection of each motor control center in accordance with ANSI/NETA ATS. Inspection shall include:
 - 1) Inspect for proper anchorage, damage, and grounding.
 - 2) Verify all overload and device settings.
 - 3) Check tightness of bolted connections.
 - b. Electrical Tests: Perform electrical testing of each motor control center in accordance with ANSI/NETA ATS. Testing shall include:
 - 1) Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
 - 2) Measure insulation resistance of each starter phase-to-phase and phase-to-ground.
 - 3) Measure insulation resistance of each control circuit with respect to ground.
 - 4) Test motor overload units by current injection.
 - 5) Perform operational tests by initiating control devices for proper operation.
 - 6) Perform contact resistance test and insulation resistance test for each circuit breaker.
 - 7) Determine long-time, short-time, and instantaneous pick-up and delay as required.

- B. Manufacturer's Services: Provide a qualified, factory trained serviceman to perform the following:
 1. Supervise unloading and installation of equipment.
 2. Instruct CONTRACTOR in installing equipment.
 3. Inspect, test, and adjust equipment after installation and ensure proper operation.
 4. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
 5. Manufacturer's technician shall make visits to the Site as follows:
 - a. First visit shall be for supervising unloading and handling of equipment and for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Technician shall train installing personnel in advance in proper handling and rigging of equipment. Minimum number of hours on-Site: 8 hours.

- b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Technician shall test the system as specified in Article 3.03.A of this Section. Technician shall operate and test the system in the presence of ENGINEER and verify that equipment complies with the Contract Documents and manufacturer's requirements. Technician shall adjust the system to initial settings as specified in Article 3.04 of this Section. Minimum number of hours on-Site: 16 hours.
 - c. Third visit shall be to instruct operations and maintenance personnel.
 - 1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.
 - 2) Training requirements, duration of instruction, and other requirements shall be in accordance with Section 01800, Equipment and System Training.
 - 3) Number of hours on-Site shall be in accordance with Division 1.
 - d. Technician shall revisit the Site as often as necessary until installation is acceptable.
 - e. Furnish services of manufacturer's factory-trained service technicians to correct defective Work within 72 hours of notification by OWNER during the correction period.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.04 ADJUSTING

- A. Calibrate, set, and program all protective devices. Coordinate protective devices furnished under this Section and provide proper settings of devices in accordance with the study performed under Section 16215, Electrical Power Distribution System Studies.

END OF SECTION 16423

NO TEXT ON THIS PAGE

SECTION 16442

PANELBOARDS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install panelboards.

B. Related Sections:

1. Section 01330, Submittals.
2. Section 16050, General Provisions for Electrical Systems.
3. Section 16075, Identification for Electrical Systems.
4. Section 16282, Surge Protective Devices.
5. Section 16423, Motor Control Centers.

1.02 REFERENCES

A. Standards referenced in this Section are:

1. NEMA PB 1, Panelboards.
2. UL 67, Panelboards.

1.03 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Listing of panelboards to be furnished with identification of their proposed location and all electrical characteristics including number and rating of branch circuit breakers and enclosure type.
2. Product Data:
 - a. Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements; Comply with the following:

1. NEC Article 408, Switchboards and Panelboards.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:

1. Packing:
 - a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
 - b. Protect mating connections.
 - c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
3. Comply with Section 01600, Materials and Equipment.

B. Storage and Protection:

1. Store panelboards in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
2. Comply with Section 01600, Materials and Equipment.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Panelboards:

1. Manufacturers: Provide products of one of the following:
 - a. Rockwell/Allen-Bradly.
 - b. Eaton/Cutler-Hammer.
 - c. Schneider/Square D.
2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
4. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 14,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 10,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.
5. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.

6. Main: Panelboards shall have main circuit breaker unless the Drawings specifically indicate main lugs only.
7. Connect branch circuit breakers for sequence phasing.
8. Enclosures: Panel enclosures shall be as required for the area classifications indicated in Section 16050, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
9. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
10. Trim: Surface or flush as required.
11. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
12. Identification: Identify panelboards in accordance with Section 16075, Identification for Electrical Systems. Identification shall indicate panel number and voltage.
13. Directory of Existing Panelboards: When adding or removing breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.
14. Provide surge protective device in accordance with Section 16282, Surge Protective Devices, for each panelboard shown or indicated on the Drawings. Surge protective device shall be included and factory-mounted within panelboard by panelboard manufacturer. Surge protective device monitoring and display shall be visible from front of panelboard.

PART 3 – EXECUTION

3.01 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.
- B. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.
- C. Arrange circuits to balance the loads on the panelboards.
- D. Identify panelboards in accordance with Section 16075, Identification for Electrical Systems.
- E. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

END OF SECTION 16442

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