TECHNICAL SPECIFICATION

FOR

EAST END BOOSTER PUMP STATION

FEBRUARY 2023

consor

TECHNICAL SPECIFICATIONS

FOR

CONSTRUCTION OF

EAST END BOOSTER PUMP STATION
FOR

CITY OF PENDLETON

FEBRUARY 2023

CONSOR
345 BOBWHITE COURT, SUITE 230
BOISE, ID 83706
208-947-9033

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SECTION 00 01 07 - SEALS PAGE
FOR
EAST END BOOSTER PUMP STATION
FOR
CITY OF PENDLETON

KRISTOFOR R. SNIDER = KRS
DENNIS GALINATO = DG
TRAVIS G. McFERON = TGM
MIKE WALLIS = MW

RENEWS 6/30/2024

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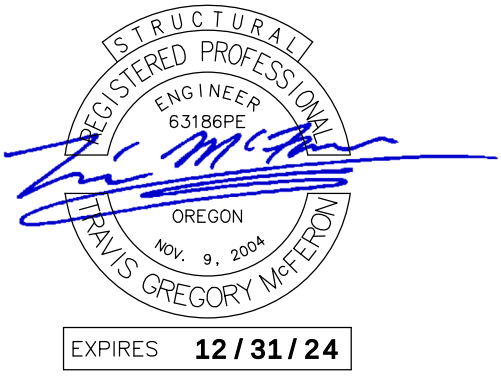

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SECTION 00 01 10 – TABLE OF CONTENTS
FOR
EAST END BOOSTER PUMP STATION
FOR
CITY OF PENDLETON

DRAWINGS
See Sheet G-1 for Drawing Index

SUPPLEMENTARY INFORMATION
Geotechnical Engineering Evaluation Proposed East Side Booster Station Pendleton, Oregon. Dated January 19, 2023. Developed by GeoEngineers.

END OF SECTION

SECTION 01 22 50 - LUMP SUM MEASUREMENT AND PAYMENT

PART 1 GENERAL

A. Payment for this project will be on a lump sum basis. The lump sum price shall constitute full compensation for all work required by the contract documents. Contractor shall submit a schedule of values to the Owner as required by the contract documents. Items for this project include:

1. Mobilization (as defined in the Contract Documents).
2. Erosion control
3. Construction survey and staking.
4. Flowmeter Vault;
5. Site piping;
6. Earthwork
7. Site paving;
8. CMU building, complete;
9. Mechanical piping, Valves, fittings, and equipment;
10. HVAC; and
11. Electrical and controls.

END OF SECTION

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SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section contains administrative and procedural requirements for submittals for review, information, and for Project closeout.

B. Section includes:

1. Schedule of Submittals.
2. Submittal requirements.
3. Submittal procedures.
4. Owner’s Representative review.
5. Resubmittal procedures.
6. Product data.
7. Shop Drawings.
8. Samples.
9. Design data.
10. Test reports.
11. Certificates.
12. Manufacturer's instructions.
13. Manufacturer's field reports.
14. Erection Drawings.
15. Construction progress schedules.
16. Breakdown of contract price.
17. Operation and maintenance (O&M) instructions.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Owner’s Representative's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Owner’s Representative's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SCHEDULE OF SUBMITTALS

A. Within 10 days after the Effective Date of the Contract, Contractor shall submit to Owner’s Representative a preliminary Schedule of Submittals, including proposed list of major products proposed for use, with specification section reference, name of Manufacturer, supplier, trade name, subcontractor, and model number of each

product. Provide a schedule of specific target dates for the submission and return of submittals and shop drawings required by the Contract Documents.

B. For products specified only by reference standards, indicate Manufacturer, trade name, model or catalog designation, and reference standards.

C. The list and schedule shall be updated and resubmitted when requested by the Owner's Representative.

D. Contractor's Schedule of Submittals will be acceptable to the Owner's Representative if it provides a workable arrangement for reviewing and processing the required submittals.

1.4 SHOP DRAWING AND SAMPLE SUBMITTAL REQUIREMENTS

A. Before submitting a Shop Drawing or Sample, Contractor shall have:

1. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

3. determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

B. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that submittal, and that Contractor approves the submittal.

C. With each submittal, Contractor shall give Owner's Representative specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Owner's Representative for review of each such variation.

1.5 SUBMITTAL PROCEDURES

A. Contractor shall submit Shop Drawings and Samples to Owner's Representative for review in accordance with the accepted Schedule of Submittals.

B. Transmit each submittal with Owner's Representative-accepted transmittal form certifying compliance with requirements of Contract Documents.

C. Sequentially number transmittal forms. Mark transmittal forms for resubmittals with original number and sequential alphabetic suffix.

D. Show each Submittal with the following numbering and tracking system:

1. Submittals shall be numbered according to specification section. For example, the first product submittal for Section 05 50 00 would be "05 50 00-1". Resubmittals of that submittal would be "05 50 00-1.1", followed by "05 50 00-1.2", and so on. The second product submittal for that Section would be "05 50 00-2".

2. Submittals containing product information from multiple sections of the specifications will not be reviewed. Contractor and/or their supplier shall divide submittals in a manner that meets the numbering and tracking system requirements stated herein.

3. Alternative method of numbering may be used if acceptable to Owner's Representative.

E. Identify: Project, Contractor, subcontractor and supplier, pertinent drawing and detail number, and specification Section number appropriate to submittal.

F. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

G. Coordinate submission of related items.

1. All shop drawings for interrelated items shall be scheduled for submission at the same time.

2. The Owner's Representative may hold shop drawings in cases where partial submission cannot be reviewed until the complete submission has been received or where shop drawings cannot be reviewed until correlated items affected by them have been received. When such shop drawings are held, the Owner's Representative will advise the Contractor in writing that the shop drawing submitted will not be reviewed until shop drawings for all related items have been received.

H. When hard copies of submittals are provided by the Contractor, six copies of all materials shall be provided to the Owner's Representative. Two copies of reviewed submittals will be kept by the Owner's Representative, two copies of reviewed submittals will be transmitted to the Owner, and two copies of reviewed submittals will be returned to the Contractor. If the Contractor requests that more than two copies of the reviewed submittal be returned, then the Contractor shall submit the appropriate quantity of submittals.

I. When electronic transmittals of submittals are provided by the Contractor under established protocols described elsewhere in the Contract Documents or as jointly developed by the Owner, Owner's Representative and Contractor, provide electronic submittals in portable document format (PDF) in addition to the source document format (Word, Excel, AutoCAD, etc.). Reviewed submittals will be returned to the Contractor as PDF electronic files.

J. For each submittal for review, allow not less than 14 days for Owner's Representative review, excluding delivery time to and from Contractor.

K. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

L. Allow space on submittals for Contractor and Owner's Representative review stamps or comments.

M. When revised for resubmission, the Contractor shall identify changes made since previous submission. A narrative of changes shall be provided, and shop drawings or calculations shall indicate that a revision was made.

N. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with review comments.

O. Submittals not requested will not be recognized nor processed.

P. Incomplete Submittals: Owner's Representative will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Owner's Representative.

1.6 OWNER'S REPRESENTATIVE REVIEW

A. Informational submittals and other similar data are for Owner's Representative's information, do not require Owner's Representative's responsive action, and will not be reviewed or returned with comment.

B. The Owner's Representative's review of submittals and shop drawings is not a check of any dimension or quantity and will not relieve the Contractor from responsibility for errors of any sort in the submittals and shop drawings.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. The Owner's Representative will review the submitted data and shop drawings and return to the Contractor with notations thereon indicating "No Exception Taken", "Make Corrections Noted", "Rejected", "Revise and Resubmit", or "Submit Specified Item".

E. If more than two submissions of an item are required to meet the Project specifications, Contractor shall be responsible for Owner's Representative's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

F. Owner's Representative will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Owner's Representative. Owner's Representative's review will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

G. Owner's Representative's review will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.

H. Owner's Representative's review of a separate item as such will not indicate approval of the assembly in which the item functions.

I. Owner's Representative's review of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 1.4.C and Owner's Representative has given written acceptance of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Owner's Representative will document any such accepted variation from the requirements of the Contract Documents in a Field Order.

J. Owner's Representative's review of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 1.4 A. and B.

K. Owner's Representative's review of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

L. Neither Owner's Representative's receipt, review, return of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.

M. Contractor shall perform the Work in compliance with the requirements and commitments set forth in returned Shop Drawings and Samples, subject to the provisions of Paragraph 1.6.I.

1.7 RESUBMITTAL PROCEDURES

A. Contractor shall make corrections required by Owner's Representative and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Owner's Representative on previous submittals.

B. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required review of an item with no more than two submittals. Owner's Representative will record Owner's Representative's time for reviewing a third or subsequent submittal of a Shop Drawings, sample, or other item requiring review, and Contractor shall be responsible for Owner's Representative's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

C. If Contractor requests a change of a previously reviewed submittal item, Contractor shall be responsible for Owner's Representative's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

PART 2 PRODUCTS

2.1 CONSTRUCTION PROGRESS SCHEDULES

A. Within 10 days after the Effective Date of the Contract, prepare and submit to the Owner's Representative a practicable schedule showing the order in which the Contractor proposes to carry out the Work, the dates on which the important features of the work will start, and the contemplated dates for completing same. In addition to a time-scaled bar chart schedule depicting the Project critical path, the Contractor shall submit a detailed CPM logic diagram. The CPM diagram and time-scaled bar chart shall include the following:

- Construction activities
- Submittal and review of material samples and shop drawings
- Procurement and delivery of critical materials
- Fabrication, installation, and testing of special material and equipment

- Duration of work, including completion times of all stages and their sub-phases

The activities shall be separately identifiable by coding or use of sub-networks or both. The duration of each activity shall be verifiable by manpower and equipment allocation, in common units of measure, or by delivery dates and shall be justifiable by the Contractor upon the request of the Owner's Representative.

Detailed subnetworks will include all necessary activities and logic connectors to describe the work and all restrictions to it. In the restraints, include those activities from the Project schedule which initiated the subnetwork as well as those restrained by it.

Include a tabulation of each activity in the computer mathematical analysis of the network diagram. Furnish the following information as a minimum for each activity:

- Event (node) number(s) for each activity
- Activity description
- Original duration of activities (in normal workdays)
- Estimated remaining duration of activities (in normal workdays)
- Earliest start date or actual start date (by calendar date)
- Earliest finish date or actual finish date (by calendar date)
- Latest start date (by calendar date)
- Latest finish date (by calendar date)
- Slack or float time (in workdays)

Computer printouts shall consist of at least a node sort and an "early start/total-float" sort.

B. Attention is drawn to typical local climatic weather patterns and Work shall be coordinated accordingly.

C. Complete Project schedule shall be revised and resubmitted to the Owner's Representative at a minimum occurrence of every 4 weeks for review.

D. Three Week Lookahead Schedules: Provide each week at the weekly construction meeting. The previous week's completed work shall be shown on the schedule for a total of 4 weeks shown.

2.2 BREAKDOWN OF CONTRACT PRICE

A. Within 10 days after the Effective Date of the Contract, submit a complete breakdown of all lump sum bid items showing the value assigned to each part of the work, including an allowance for profit and overhead adding up to the total lump sum contract price.

B. Breakdown of lump sum bids shall be coordinated with the items in the schedule and shall be in sufficient detail to serve as the basis for progress payments during construction.

C. Owner's Representative will review the contract price breakdown and may request items to be further broken down or for more items be added in order to facilitate tracking of work progress for payment.

D. Preparatory work, bonds, and insurance required in setting up the job will be allowed as a separate entry on the cost breakdown but shall not exceed 5 percent of the total base bid.

E. Upon acceptance of the breakdown of the contract price by the Owner's Representative, it shall be used as the basis for all requests for payment.

2.3 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Owner's Representative for review for assessing conformance with information given and design concept expressed in Contract Documents. Submitted data shall be sufficient in detail for determination of compliance with the Contract Documents.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement Manufacturers' standard data to provide information specific to this Project.

1. Note submittal will be returned to Contractor without review of submittal if products, models, options, and other data are not clearly marked or identified.

C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

2.4 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Owner's Representative for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Owner's Representative licensed in the state of Project, responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design.

2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.

3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. All dimensioned shop drawings shall be scalable and provided as full-sized (22-inch x 34-inch) sheets. PDF electronic files shall print as scalable full-sized sheets.

E. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

2.5 SAMPLES

A. Samples: Action Submittal: Submit to Owner's Representative for assessing conformance with information given and design concept expressed in Contract Documents.

B. Samples for Selection as Specified in Product Sections:

1. Submit to Owner's Representative for aesthetic, color, and finish selection.

2. Submit Samples of finishes, textures, and patterns for Owner selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

D. Include identification on each Sample, with full Project information.

E. Submit number of Samples specified in individual Specification Sections; Owner's Representative will retain one Sample.

F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. NOT USED

H. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

2.6 DESIGN DATA

A. Informational Submittal: Submit data for Owner’s Representative's knowledge as Contract administrator or for Owner.

B. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

2.7 TEST REPORTS

A. Informational Submittal: Submit reports for Owner’s Representative's knowledge and records as Contract administrator or for Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

2.8 CERTIFICATES

A. Informational Submittal: Submit certification by Manufacturer, installation/application Subcontractor, or Contractor to Owner’s Representative, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product but must be acceptable to Owner’s Representative.

2.9 MANUFACTURER’S INSTRUCTIONS

A. Informational Submittal: Submit Manufacturer's installation instructions for Owner’s Representative's knowledge as Contract administrator or for Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Owner’s Representative in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

2.10 MANUFACTURER’S FIELD REPORTS

A. Informational Submittal: Submit reports for Owner’s Representative's knowledge and records as Contract administrator or for Owner.

B. Submit report within 48 hours of observation to Owner’s Representative for information.

C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

2.11 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for Owner’s Representative's knowledge and records as Contract administrator or for Owner.

B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Owner’s Representative or Owner.

2.12 NOT USED

2.13 NOT USED

2.14 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. Submit preliminary O&M materials for review by Owner’s Representative. The Equipment Manufacturer may furnish instruction manuals prepared specifically for the equipment furnished or standard manuals may be used if statements like "if your equipment has this accessory..." or listings of equipment not furnished are eliminated. O&M materials will be returned to the Contractor for resubmittal if the O&M materials do not clearly indicate what specific equipment was furnished and all items not provided being clearly crossed out. Poorly reproduced copies are not acceptable. Operation and maintenance instructions shall contain the following as a minimum:

1. Reviewed shop drawings and submittal data;

2. Model, type, size, and serial numbers of equipment furnished;

3. Equipment and driver nameplate data;

4. List of parts showing replacement numbers;

5. Recommended list of spare parts;

6. Complete operating instructions including start-up, shutdown, adjustments, cleaning, etc.;

7. Maintenance and repair requirements including frequency and detailed instructions; and

8. Name, address and phone numbers of local representative and authorized repair service.

B. Following review of the preliminary O&M materials by the Owner's Representative and before acceptance of the Work, submit:

1. Four hard copies of complete final operation and maintenance instructions for all equipment supplied. Submit items in 8-1/2 x 11-inch heavy-duty three-ring binders when appropriate, or in 8-1/2 x 11-inch file folders. All binders and folders shall have clear plastic pockets on the front of the cover and the spine to allow for insertion of identifying information.

2. Two searchable electronic PDF copies of full O&M materials. Provide each electronic copy on its own individual thumb drive of disc.

2.15 OTHER REQUIRED SUBMITTALS

A. Other required submittals include the items listed below. This list is provided for Contractor's convenience only and may not be complete in all respects. Contractor shall provide all submittals specified or required, whether or not listed here.

1. Contractor Emergency Contact List.
2. Erosion and Sediment Control Plan.
3. Traffic Control and Protection Plan.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 45 00 - QUALITY CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section covers quality control requirements supplementary to those of the General Conditions and Technical Specifications.

1.2 PROVISIONS

A. Contractor's Responsibility for Testing

The Contractor shall be responsible for the cost of all testing as specified in this section. Additional information has been provided regarding the payment responsibility for the Owner with regards to the Project.

B. Owner's Right to Perform Additional Tests

The Owner or Owner's Representative reserves the right to complete additional testing. In such cases, the Contractor shall provide safe access for the Owner or Owner's Representative and their inspectors to adequately inspect the quality of work and the conformance with Project specifications.

1.3 QUALITY ASSURANCE

A. Testing Requirements

An independently owned and operated laboratory approved by the Owner's Representative shall perform all testing as specified herein.

B. Testing

1. General

a. All required testing of work and/or materials shall be conducted in the presence of the Owner's Representative. The Contractor shall provide 48-hour notification to the Owner and Owner's representative prior to conducting any and all quality assurance testing. Where applicable, work and materials shall only be buried with the consent of the Owner's Representative.

b. Where such inspection and testing are to be conducted by an independent laboratory or agency, the sample, or samples of material to be tested shall be selected by such laboratory or agency or by the Owner's Representative. The Contractor shall furnish such samples of all materials without charge to Owner.

c. The results from any and all tests are made for the information of the Owner. Regardless of any test results, the Contractor is solely responsible for the quality of workmanship and materials and for compliance with the requirements of the Drawings and Specifications.

2. Costs of Testing

a. The Contractor shall be responsible for and shall pay for all tests required in the contract documents.

b. With regards to all materials to be tested, where test results demonstrate that the material or workmanship does not meet the minimum requirements of the Contract Documents, additional testing shall be completed and shall be paid for by the Contractor with no reimbursement by the Owner.

1.4 SPECIAL INSPECTIONS

Special inspections and testing shall be conducted by Owner-retained Special Inspectors and Testing Agencies as required and as indicated in the Contract Documents.

A. Special Inspectors and Testing Agencies Responsibilities

1. Verify that manufacturers maintain detailed fabrication and quality control procedures and review the completeness and adequacy of those procedures to perform the Work.

2. Promptly notify Owner and Contractor of irregularities and deficiencies observed in the Work during performance of their services.

3. Submit certified written report of each test, inspection and similar quality control service to Owner, Contractor, and jurisdictional authorities. Interpret test results and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

4. Submit final report of special inspections at Substantial Completion, including a list of unresolved deficiencies.

5. Re-test and re-inspect corrected work.

B. Contractor's Responsibilities

1. Provide quality requirements to all subcontractors and enforce all requirements.

2. Notify Owner, Owner's Representative, Special Inspectors and Testing Agencies at least 48 hours in advance of time when Work that requires testing or special

inspecting will be performed, unless otherwise indicated in the Contract Documents.

3. Pay for any Contractor requested testing and inspecting not required by the Contract Documents.

4. Pay for any re-testing or re-inspections by Special Inspectors and Testing Agencies for replacement work resulting from work that failed to comply with the Contract Documents. Owner will deduct such costs from the Contract Price.

5. Submit copies of licenses, certifications, correspondence, records, and similar documents used to establish compliance with standards and regulations that pertain to performance of the Work to the Owner, Owner's Representative, and Special Inspectors.

6. Where Special Inspection requires pre-construction testing for compliance with specified requirements for performance and test methods, comply with the following:

    a. Provide test specimens representative of proposed products and construction in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

    b. Provide information on configurations of test assemblies, testing procedures and laboratory test records to adequately demonstrate capability of products to comply with performance requirements.

7. Cooperate with Agencies performing required tests, special inspections, and similar quality control services. Notify Agencies in advance of operations to permit assignment of personnel. Provide the following:

    a. Access to the Work.

    b. Incidental labor, equipment, and materials necessary to facilitate tests and special inspections.

    c. Adequate quantities of representative samples of materials that require testing and inspecting. Assist Agencies in obtaining samples.

    d. Provide facilities for storage and field curing of test samples.

    e. Deliver samples to Testing Agencies.

8. Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and special inspecting.

9. Schedule times for tests, special inspections, obtaining samples, and similar activities. Distribute schedule to Owner, Owner's Representative, Special Inspectors, Testing Agencies, and each party involved in portions of the work where tests and special inspections are required.

1.5 ENGINEER OF RECORD OBSERVATIONS

A. The OWNER shall employ the Owner's Representative of Record or an alternate Oregon-licensed Professional Owner's Representative approved by the Owner's Representative of Record to perform certain structural observations in accordance with requirements shown in the Drawings.

B. Owner's Representative of Record Responsibilities

1. Verify that Contractor maintains detailed fabrication and quality control procedures and review the completeness and adequacy of those procedures to perform the Work.

2. Promptly notify OWNER and CONTRACTOR of irregularities and deficiencies observed in the Work during performance of their services.

3. Submit certified written report of each observation and similar quality control service to OWNER, CONTRACTOR and jurisdictional authorities. Interpret test results and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

4. Submit final report of observations at Substantial Completion, including a list of unresolved deficiencies.

5. Re-test and re-inspect corrected work

C. CONTRACTOR'S Responsibilities

1. Provide quality requirements to all subcontractors and enforce all requirements.

2. Notify Owner's Representative of Record at least 48 hours in advance of time when Work that requires observation will be performed, unless otherwise indicated in the Contract Documents.

3. Pay for any re-observations by Owner's Representative of Record for replacement work resulting from work that failed to comply with the Contract Documents. OWNER will deduct such costs from the Contract Price.

4. Submit copies of licenses, certifications, correspondence, records and similar documents used to establish compliance with standards and regulations that

pertain to performance of the Work to the OWNER, OWNER'S REPRESENTATIVE and Owner's Representative of Record.

5. Cooperate with Owner's Representative of Record performing required observations and quality control services. Notify Owner's Representative of Record personnel in advance of operations to permit assignment of personnel. Provide the following:

    a. Access to the Work.

    b. Incidental labor, equipment and materials necessary to facilitate tests and special inspections.

    c. Adequate quantities of representative samples of materials that require testing and inspecting. Assist Agencies in obtaining samples.

6. Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and special inspecting.

7. Schedule times for observations and similar activities. Distribute schedule to OWNER, OWNER'S REPRESENTATIVE, and Owner's Representative of Record involved in portions of the work where tests and observations are required.

D. For Owner's Representative of Record observation requirements, see the drawings.

1.6 SUBMITTALS

A. Laboratory Test or Inspection Reports

Each report shall be signed and certified by the independently owned and operated testing laboratory. Unless otherwise specified, submit three copies of each report to the Owner or Owner's Representative.

PART 2 PRODUCTS – (Not Used)

PART 3 EXECUTION

3.1 FIELD TESTING SCHEDULE

The Contractor shall complete field testing in accordance with the technical specifications.

END OF SECTION

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SECTION 01 61 10 - SEISMIC REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

PART 1 GENERAL

1.1 SUMMARY

A. This section contains seismic design requirements for non-structural equipment, components and systems. The components and systems indicated below are required for immediate re-occupancy and minimization of disruption to operations following a seismic event. All elements shall meet the requirements of this section and Chapter 13 of ASCE 7-16.

B. Applicable Specification Divisions include those with:

1. Components that are part of the Designated Seismic Systems as covered in the 2019 OSSC Section 1705.13.3 and subject to the requirements of ASCE 7 Section 13.2.2.

2. Components weighing more than 400 pounds that have a center of mass located 4-feet or less above the adjacent floor or roof level that supports the component.

3. Components weighing more than 20 pounds, or more than 5 lbs./ft. in the case of distributed systems, located more than 4-feet above the adjacent floor or roof level that supports the component.

4. Exceptions:

   a. Furniture

   b. Temporary or movable equipment

   c. Mechanical and electrical components in Seismic Design Category B

   d. Mechanical and electrical components in Seismic Design Category C provided that either:

      1) The component Importance Factor, Ip, is equal to 1.0 and the component is positively attached to the structure; or

      2) The component weighs 20 lbs or less

1.2 RELATED SECTIONS:

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. General provisions within other Specification Divisions related to hangars, anchors, supports and seismic restraint or seismic control.

1.3 DEFINITIONS

A. Active – An active system is one that has moving parts.
B. Non-Active – A non-active system is one that has no moving parts.

1.4 ACCEPTED STANDARDS

A. ASCE 7-16 Section 13.2.2 requires certification be provided for active mechanical, electrical, and containment and storage equipment that is identified as being assigned to the Designate Seismic System. This designation requires said systems to remain operable and functional following the design earthquake ground motion. Documentation confirming suitability shall be provided as outlined in the Submittal Section.

B. ASCE 7-16 Section 13.1.7 allows for the use of reference documents or standards for industry specific systems or components which represent acceptable procedures for seismic design and construction. The use of these documents or standards does not alleviate the SELLER from submitting calculations, drawings and product data that show conformance to the requirements of this section.

C. Pre-approved details meeting the requirements of ASCE 7-16 Section 13.3 may be used for this project without submitting calculations indicating compliance with the design criteria specified in Section 1.6 Design Criteria. The SELLER shall provide shop drawings detailing the product and specifying the pre-approved detail(s) to be used and their locations along with supporting documentation.

1.5 SUBMITTALS

A. Special Certifications for the Designated Seismic System:

1. For Active Mechanical and Electrical Equipment, submit one of the following forms of documentation for each main component of the system.

   a. Approved Shake Table Test results per ASCE 7 Section 13.2.5

   b. Experience Data per ASCE 7 Section 13.2.6

   c. Inherent Ruggedness per ASCE 7 Section 13.2.5, See Section 1.9 for equipment that may be considered Inherently Rugged

2. For Non-Active Mechanical and Electrical Equipment, submit one of the following forms of documentation for each main component of the system.

   a. Analysis per ASCE 7 Section 13.2.2

   b. Approved Shake Table Test results per ASCE 7 Section 13.2.5

c. Experience Data per ASCE 7 Section 13.2.6

d. Inherent Ruggedness per ASCE 7 Section 13.2.5, See Section 1.9 for equipment that may be considered Inherently Rugged

3. For component with hazardous substances, submit one of the following forms of documentation for each main component of the system..

   a. Analysis per ASCE 7 Section 13.2.2
   b. Approved Shake Table Test results per ASCE 7 Section 13.2.5
   c. Experience Data per ASCE 7 Section 13.2.6

4. Certification of components through analysis shall be limited to nonactive components and shall be based on seismic demand considering Rp/Ip equal to 1.0 as required by ASCE Section 13.2.2.3

5. Certificate of Compliance.

   a. Where seismic certification is required a certification and equipment label shall be provided:

      1) Certificate: A certificate issued by the manufacturer stating that materials and products meet specified standards and the work was done in compliance with approved construction documents. Certificate of compliance shall, among other things, specify the validity range for Sds, Z/h, Ip and method of qualification.

      2) Label. An identification applied on a product by the manufacturer that contains the name of the manufacturer, model number, serial number, or definitive information describing the product material, the function and performance characteristics of the product or material, and the name of an approved agency, and that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency.

B. Product data: Illustrate and indicate style, material, strength, fastening provision and finish for each type and size of seismic restraint component used.

C. Shop drawings: Submit shop drawing plans and details indicating horizontal and vertical location (with respect to floor level and grids) layout, spacing, sizes and types of seismic restraint and gravity supports for each system or component requiring bracing. The connection details shall be on similar size plan sheets and clearly presented in the electronic submittal document. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices. Shop drawings shall be stamped by a registered Structural Engineer in the State of Oregon. The shop drawings must be clearly organized and presented such that they can be readily interpreted by the CONTRACTOR for installation and the Special Inspector. Include the following:

1. Fabricated Support: representations of field-fabricated supports not detailed on the Shop Drawings.

2. Seismic Restraints: Detail anchorage and bracing not defined by other details or charts on the Shop Drawings. Include the following:

3. Design: To support selection and arrangement of seismic restraints, include calculations of combined tensile, compressive and shear loads. NOTE: Anchorage to concrete shall comply with ACI 318-14, Chapter 17 assuming cracked concrete conditions.

4. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods and spacing. Identify components, list their strengths and indicate directions and values of forces transmitted to the structure during seismic events.

D. Calculations: Calculations shall be submitted together with the Shop Drawings. Calculations shall substantiate the design of the sizes, thicknesses, and types of seismic-restraint connections, gravity support connections, fabrication, and attachment (fastening, anchorage, welding, etc.) to the structure, including all fasteners. Calculations shall clearly indicate the loads imposed on the primary building structure, including magnitude, direction and location. Calculations shall be based upon the design requirements in Section 1.6 Design Criteria shall be stamped by a registered Structural Engineer in the State of Oregon.

E. Welding certificates of welders performing component or system installation.

F. Field Quality Control Reports

G. Field Observation Reports from the Special Inspector

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in ASCE 7-16 unless requirements in this Section are more Stringent.

1.7 DESIGN CRITERIA

A. General. Seismic Demands on Non-Structural Components per ASCE 7-16 Section 13.3 are superseded by Sections 1.7.B and 1.7.C below. Conform to all other Sections of ASCE 7-16 Chapter 13.

B. Horizontal seismic forces. Design and detail all members and connections to meet the requirements of ASCE 7-16 based on the actual system or component operating weight. The design and evaluation of components and their support and attachments

shall consider their flexibility as well as their strength. The following forces shall be used for all design and calculations.

1. Seismic Design Category: D

2. Risk Category: IV

3. F_p = horizontal seismic design force applied in any direction

   $F_p = 0.4\ S_{DS}\ [(a_p W_p)(1+2z/h)]/(R_p/I_p)$
   $F_{pMAX} = 1.6\ I_p\ S_{DS}\ W_p$
   $F_{pMIN} = 0.3\ I_p\ S_{DS}\ W_p$

4. a_p = component amplification factor, per ASCE 7-16 Chapter 13, unless specified elsewhere within individual Specification Divisions or individual Specification Sections

5. R_p = component response modification factor, per ASCE 7-16 unless specified elsewhere for individual Division or Specification Sections

6. W_p = component operating weight

7. Ω_0 = Overstrength Factor, per ASCE 7-16 Chapter 12, unless specified elsewhere within individual Specification Divisions or individual Specification Sections.

8. I_p = 1.5, component importance factor.

9. z = height (in feet) above ground floor for the attachment of the component (see drawings for floor elevations). z shall be taken as zero below grade. The value of z/h need not exceed 1.0.

10. h = roof height above grade.

11. S_{DS} = 0.315, Short Period Design Spectral Response Acceleration

C. Vertical seismic forces. Calculate vertical seismic force by the following equation. The design force shall be applied vertically at the center of gravity of the component or distributed according to the mass distribution of the component or system. The vertical seismic force shall be combined with the horizontal seismic force as well as the Dead Load gravity force to determine the maximum force for component or anchorage design. Combine horizontal and vertical effects as indicated in ASCE 7-16, Section 13.3.1.

   $F_{pV} = +/-0.2\ S_{DS} W_p$

D. Seismic attachments, bracing and anchorage shall be designed such that the component force is transferred to the lateral force resisting system of the structure

through a complete load path. Attachments shall not be made across expansion and contraction joints.

E. Components with vibration isolation systems shall have snubbers in each horizontal direction and vertical restraints as necessary to resist overturning.

F. The seismic anchorage system shall provide restraint in all directions, including vertical, for each component or system for which seismic design is required.

1.8 LIST OF EQUIPMENT AND COMPONENTS REQUIRING SPECIAL SEISMIC CERTIFICATION

A. The following is a list of equipment and components that require special certification. This is not an exhaustive list and is intended to provide guidance on types of equipment that may require special seismic certification.

1. Emergency and standby power systems equipment including generators, fuel tanks, and automatic transfer switches.

2. Motor control centers

3. HVAC Equipment

4. Distribution panels, including electrical panel boards

5. Control panels

1.9 RUGGED EQUIPMENT AND COMPONENTS

A. The equipment and components listed below are considered inherently rugged and must be considered to meet the requirements for seismic certification by experience data.

1. Valves (not in cast-iron housings, except for ductile cast iron)

   Motors and motor operators

2. Pumps

1.10 EXEMPTIONS

A. Equipment and components weighing not more than 20 lbs. Supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with ASCE 7 Chapter 13.

B. Factory assembled discrete equipment and components.

PART 2 PRODUCTS

A. (NOT USED)

PART 3 EXECUTION

A. (NOT USED)

END OF SECTION

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SECTION 01 75 00 - TESTING, TRAINING, AND COMMISSIONING

PART 1 GENERAL

1.1 SCOPE

This section specifies equipment and system testing and start-up, services of Manufacturer's representatives, training of Owner's personnel, and final testing requirements for the complete facility.

1.2 CONTRACT REQUIREMENTS

A. Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete all testing, training, and start-up within the Contract Time(s).

C. Furnish all necessary labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

D. Provide competent, experienced technical representatives of Equipment Manufacturers for assembly, installation, testing, and operator training.

1.3 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 2 weeks prior to planned initial equipment or system start-up.

B. Provide detailed Start-up Progress Schedule with the following activities identified:

1. Manufacturer’s services
2. Installation certifications
3. Operator training
4. Submission of operation and maintenance manual
5. Functional testing
6. Performance testing
7. Operational testing

C. Provide testing plan with test logs for each item of equipment and/or system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems if required, which are necessary to complete start-up of new equipment and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.4 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical Systems:

1. Remove rust preventatives and oils applied to protect equipment during construction.

2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by Manufacturer.

3. Flush fuel system and provide fuel for testing and start-up.

4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.

5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.

6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.

7. Perform cold alignment and hot alignment to Manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.

9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to ensure no leakage but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.

10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.

11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical Systems

1. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.

2. Perform continuity tests on grounding systems.

3. Test and set switchgear and circuit breaker relays for proper operation.

4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.

5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation Systems

1. Bench or field calibrate instruments and make required adjustments and control point settings.

2. Leak test pneumatic controls and instrument air piping.

3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.5 FUNCTIONAL TESTING

A. Functionally test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed.

B. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the Manufacturer's representative.

C. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

D. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.6 CERTIFICATE OF PROPER INSTALLATION

A. At completion of functional testing, furnish written report prepared and signed by Manufacturer's authorized representative, certifying equipment:

1. Has been properly installed, aligned, adjusted, and lubricated.

2. Is free of any stresses imposed by connecting piping or anchor bolts.

3. Is suitable for satisfactory full-time operation under full load conditions.

4. Operates within the allowable limits for vibration.

5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.

6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:

1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.

2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.

C. Co-sign the reports along with the Manufacturer's representative and subcontractors.

1.7 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize Manufacturer's representatives to conduct training sessions.

B. Coordinate training schedule with City staff. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than two sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 2 weeks prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. The Owner may videotape the training for later use with the Owner's personnel.

1.8 MINIMUM SERVICE SCHEDULE

Minimum services shall be provided as specified in the technical specifications.

1.9 OPERATIONAL TESTING

A. Conduct operational test of the entire facility after completion of operator training. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. Owner will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.10 RECORD KEEPING

A. Maintain and submit to Owner’s Representative the following records generated during start-up and testing phase of Project:

1. Daily logs of equipment testing identifying all tests conducted and outcome.

2. Logs of time spent by Manufacturer's representatives performing services on the job site.

3. Equipment lubrication records.

4. Electrical phase, voltage, and amperage measurements.

5. Insulation resistance measurements.

6. Pump torsional and lateral vibration analysis report.

7. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

END OF SECTION

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SECTION 02 30 00 - SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.1 SUMMARY

A. Subsurface investigations and reporting have been performed for the purpose of obtaining data for the planning and design of this Project. Copies of such reporting are attached to the Contract Documents as Supplementary Information.

1.2 LIMITATIONS

A. The subsurface investigations and reporting are being made available solely for the convenience of the Bidder and shall not relieve the Bidder or the Contractor of any risk, duty to make examinations and investigations as required by Article 4 of the Instructions to Bidders, or any other responsibility under the Contract Documents.

B. It is mutually agreed to by all parties:

1. Written reports are reference documents and are not part of the Contract Documents.

2. Subsurface investigations are for the purpose of obtaining data for planning and design of the Project.

3. Data concerning borings and test pits is intended to represent with reasonable accuracy conditions and material found in specific borings and test pits at the time the borings and test pits were made.

C. It is expressly understood and agreed the Owner and Owner's Representative assume no responsibility whatsoever in respect to the sufficiency or accuracy of the investigation thus made, the records thereof, or of the interpretations set forth therein, or made by the Owner in the Owner's use thereof; and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations, or records thereof, are representative of those existing throughout such areas, or any part, or that unforeseen developments may not occur.

D. The Owner's subsurface investigations and reporting are made available to Bidder or Contractor only on the basis of the understandings and agreement herein stated.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 03 21 00 - REINFORCING STEEL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all the work necessary to furnish all labor, materials, equipment, and services necessary to furnish reinforcing steel, accessories, welding, equipment and services, and place concrete reinforcement.

B. Section includes:

1. Reinforcing steel.

1.2 RELATED SECTIONS

A. Section 03 30 00 Cast-In-Place Concrete Work.
B. Section 04 22 00 Concrete Masonry Units.

1.3 SUBMITTALS

A. Section 01 33 00 Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Submit shop drawings of detailed placing and bending lists for the ENGINEER's approval before the reinforcement is fabricated.

C. Submit information on any reinforcing to be field bent as covered in Section 3.1.B.

D. Mill Certificates: Mill test certificates shall be submitted to the ENGINEER to certify that the reinforcing steel meets the specified requirements. Mill test certificates shall be furnished and paid for by the CONTRACTOR.

E. In addition, the ENGINEER may require that test samples be taken, and test certificates be furnished by a reputable material testing laboratory at the OWNER's expense.

1.4 REFERENCES

A. American Concrete Institute (ACI)

1. ACI 117 “Specifications for Tolerances for Concrete Construction and Materials and Commentary”

B. American Welding Society (AWS)

1. AWS D1.4 “Structural Welding Code – Reinforcing Steel”

C. ASTM International (ASTM)

1. ASTM A184 "Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement"

2. ASTM A615 "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"

3. ASTM A706 "Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement"

4. ASTM A767 "Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement"

5. ASTM A775 "Standard Specification for Epoxy-Coated Steel Reinforcing Bars"

6. ASTM A884 "Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement"

7. ASTM A934 "Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars"

8. ASTM A955 "Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement"

9. ASTM A970 "Standard Specification for Headed Steel Bars for Concrete Reinforcement"

10. ASTM A1022 "Standard Specification for Deformed and Plain Stainless-Steel Wire and Welded Wire for Concrete Reinforcement"

11. ASTM A1044 "Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete"

12. ASTM A1055 "Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars"

13. ASTM A1060 "Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete"

14. ASTM A1064 "Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete"

D. Concrete Reinforcing Steel Institute (CRSI)

1. CRSI 10MSP "(2018) Manual of Standard Practice"

2. CRSI RB4.1 "(2016) Supports for Reinforcement Used in Concrete"

1.5 QUALITY CONTROL

A. The ENGINEER may require that test samples be taken, and test certificates be furnished by a reputable material testing laboratory at the OWNER's expense.

PART 2 PRODUCTS

2.1 DEFORMED REINFORCING BARS

A. Unless otherwise specified, reinforcing steel shall be Grade 60 billet steel conforming to ASTM Specification A615 or ASTM 706.

1. All such reinforcing shall be deformed steel bars with *deformations* conforming to the requirements set forth in ASTM Specification A615 or ASTM 706

2. Stirrups and Ties shall be Grade 60.

B. Spiral reinforcement and steel wire shall be cold-drawn steel wire conforming to the requirements of ASTM Specification A82 unless shown otherwise on the Drawings.

C. Welded Wire Fabric (WWF) shall conform to ASTM Specification A185.

D. Bar and rod mats for concrete reinforcement conforming to ASTM A184

E. Tie wire, 16 gauge or heavier black annealed wire.

F. Varying grades shall not be used interchangeably in structures.

G. Reinforcing bars shall conform to the requirements of ACI 318 with lengths and bends in accordance with the fabrication tolerances of ACI 117.

1. Reinforcing bars shall be shop fabricated unless approval is provided by the ENGINEER for field bends. See Section 3.1.B for additional information on field bending.

2. Bending shall be done cold and accomplished so that the steel will not be damaged.

3. Kinked bars shall not be used.

2.2 PLAIN REINFORCING BARS

Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82 unless shown otherwise on the Drawings.

Plain smooth dowels and ¼-inch diameter smooth bars conforming to ASTM A615 Grade 60.

2.3 SUPPORTS

A. Bar supports shall conform to ACI 315 and CRSI Manual of Standard Practice, Chapter 3, Bar Supports

B. Bar supports shall consist of approved high density "adobes", stainless steel chairs, plastic spacers, or plastic shim plates.

1. Brick, broken concrete masonry units, spalls, rocks or similar materials shall not be used for support of reinforcing steel.

2. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view, such as in the roof slab.

3. Plastic spacers shall be PRECO BARSPAN WHEELS, as manufactured by the PRECO CORPORATION or equal.

4. Plastic shim plates may be used to support the plastic spacers and shall be used to support the vertical reinforcing in the corewall, unless shown otherwise on the Drawings.

C. Hot-dipped Galvanized Reinforcing Bars

When reinforcing bars are indicated on the Drawings to be hot-dipped galvanized, they shall be galvanized in accordance with ASTM A767 and ASTM A143. The grade of reinforcing bars shall be as specified under Section 2.1. The bars shall be galvanized in conformance with a Class 1 coating and shall be galvanized after fabrication and shearing.

D. Steel Tie Wire: Annealed steel tie wire shall be used to fasten the reinforcing steel in place.

PART 3 EXECUTION

3.1 REINFORCING BARS

Comply with the specified codes and standards and Concrete Reinforcing Steel Institutes recommended practice for "placing reinforcing bars," for details and methods of reinforcement placement and supports, and as herein specified.

A. General

1. Mild steel reinforcing bars shall be furnished, cut, bent and placed as indicated on the Drawings.

2. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease, oil, or other coating which might destroy or reduce its bond with concrete.

    a. Reinforcing bars with rust, mill scale or a combination of both will not be acceptable without cleaning or brushing provided that upon wire brushing a sample, the dimensions including height of deformations and weights shall not be less than the applicable ASTM requirements. Steel reinforcement which is to be placed in the work shall be stored under cover to prevent rusting and shall be placed on blocking such that no steel touches any ground surface.

3. All reinforcing steel placed in the work shall be tied together and supported in such a manner that displacement during placing of concrete and shotcrete will not occur.

4. When there is a delay in depositing concrete, reinforcement shall be re-inspected and cleaned when necessary.

B. Fabrication (Cutting and Bending)

1. Steel reinforcement shall be cut and bent in accordance with ACI 318 and to the tolerances of ACI 117 with approved practices and machine methods.

    a. Bar bending shall be performed in the shop and all bars shall be bent cold.

    b. If field bending is required, submit locations requiring field bending to the ENGINEER for review and approval.

    c. Rebending of reinforcing bars that have been bent incorrectly is not permitted.

    d. Bending, rebending, or straightening of reinforcing bars that have been cast into concrete is not permitted.

2. Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and on the bending schedule.

3. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.

4. Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

5. Do not use reinforcing that has any of the following defects:

    a. Bar lengths, depths, and bends beyond the specified fabrication tolerances.

b. Bends or kinks not indicated on the drawings or approved shop drawings.

c. Bars with reducing cross-section due to rusting or other causes.

6. Replace defective reinforcement with new reinforcement having the required shape, form, and cross-section area.

C. Minimum Bar Spacing

The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than 1-inch, nor less than the maximum size of coarse aggregate specified.

D. Concrete Cover (Minimum)

1. On all formed surfaces which will be exposed to water, ground or the elements, there shall be a nominal cover over the steel of 2.0-inches for bars number 6 through number 18 and 1-1/2 inches for bars number 5 and smaller, with an installation tolerance of + 1/4 inch. When crossing bars of different diameter are encountered in one face, one shall consider the bar size and location that will provide the largest cover over the nearest steel to the outside surface.

2. Unless otherwise specified in these specifications or shown on the Drawings, all reinforcing steel facing subgrades for concrete construction of the foundation or below-grade elements shall be given a nominal protective cover of 3.0-inch minimum. The largest cover shall be used when different size bars are encountered in one face.

3. The minimum cover over reinforcing steel for concrete construction of other facilities shall be as shown on the Drawings.

4. No "bury" or "carrier" bars will be allowed unless specifically approved by the ENGINEER.

E. Splicing

1. Except as shown or specified on the Drawings, reinforcing steel shall not be spliced at any location without specific approval by the ENGINEER. Splices in adjacent bars shall be staggered.

2. Where permitted or required, splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise on the Drawings, the bars at a lap splice shall be in contact with each other. In no event shall the lap be less than 40 diameters of the spliced bars.

3. Unless specified or shown otherwise on the Drawings, bars shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel tie wire.

4. Unless shown otherwise on the Drawings, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in a subsequent concrete placement.

F. Supports

1. All reinforcement shall be retained in place, true to indicated lines and grades, by the use of approved bar supports. The CONTRACTOR shall submit for ENGINEER's approval, samples of all bar supports he proposes to use along with a written description of where each bar support will be used.

2. The supports shall be of sufficient quantity, strength, and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete. The CONTRACTOR shall be held responsible for providing the appropriate quantity and type of bar supports.

3. Do not place reinforcing bars more than two inches beyond the last leg on continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

G. Bar Tying

1. Bars shall be tied sufficiently often to prevent shifting. There shall be at least three ties in each bar length (this shall not apply to dowel laps or to bars shorter than 4 feet, unless necessary for rigidity).

2. Slab bars shall be tied at every intersection around the periphery of the slab. Wall bars and slab bar intersections shall be tied at not less than every fourth intersection, but at not greater than the following maximum spacings:

	Slab Bars (in)	Wall Bars (in)
Bars No. 5 and smaller	60	48
Bars No. 6 through No. 9	96	60
Bars No. 10 through No. 11	120	96

H. Reinforcement Around Openings -- Where reinforcing steel has to be cut to permit passage of pipe or to create openings, and should no detail be shown for extra reinforcing in such areas, the area of steel removed by the creation of the opening must be replaced by placing at least double the area of steel removed by the opening equally around the openings. The steel shall be placed such that it extends 5 feet beyond the opening on each side to provide for sufficient bond.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE WORK

PART 1 GENERAL

1.1 SUMMARY

A. The extent of concrete work is shown on the Drawings.

B. Work includes providing formwork and shoring for cast-in-place concrete and installation of related items including reinforcing steel bar (rebar), anchor bolts, setting plates, bearing plates, anchorages, inserts, reveals, frames, nosings, sleeves and other items to be embedded in concrete.

C. Definitions

1. Batch: Used in this specification to define an overall class of concrete as delivered from a concrete batching plant or on-site batching operation. Batching operations can continue for hours or days and as long as the class of concrete is similar, the batch would be considered the same. Multiple mixer truck loads could be used to deliver a "batch" of concrete over the course of multiple hours or days.

2. Batched/Batching: The loading of concrete, as combined and mixed at a batching/ready-mix plant, into a concrete mixer truck for delivery to the job site.

3. Truckload: A standard concrete mixer truck size is assumed to have a concrete capacity of 8 cubic yards. A truckload is used to help define the frequency of testing which of occurs per concrete mixer truck.

4. Ready-Mix Concrete: Concrete that is manufactured in a batch plant, according to a set engineered mix design. This specification assumes ready-mix concrete will be delivered by mixer truck to the job site.

1.2 RELATED SECTIONS:

A. Section 03 21 00 - Reinforcing Steel.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. For information only, submit an electronic copy of manufacturer's data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, chemical floor hardeners, dry-shake finish materials, and others. Bind and submit in one submittal.

C. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with the ACE 315 “Manual of Standard Practice for Detailing Reinforced Concrete Structures” showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete structures and indicate spacer or burner bars.

D. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually. Submit form drawings for building columns, walls, fascias, and intersections, and concrete pan and joist system. Submit for typical sections only. ENGINEER’s review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is the CONTRACTOR’s responsibility.

E. Submit electronic copy of laboratory test reports for concrete materials and mix design tests as specified.

F. Material Certificates may be provided in lieu of materials laboratory test reports. The material manufacturer and the CONTRACTOR, certifying that each material item complies with, or exceeds, the specified requirements shall sign material certificates.

1.4 REFERENCES

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified here:

A. American Concrete Institute (ACI)

ACI 301 “Specifications for Structural Concrete for Buildings”

ACI 311 “Recommended Practice for Concrete Inspection”

ACI 318 “Building Code Requirements for Reinforced Concrete”

ACI 347 “Recommended Practice for Concrete Formwork”

ACI 304 “Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete”

ACI 308 “Guide to External Curing of Concrete”

B. American Society for Testing and Materials (ASTM)

1. C31, Making and Curing Concrete Test Specimens in the Field.

2. C33, Specification for Concrete Aggregate.

3. C39, Compressive Strength of Cylindrical Concrete Specimens.

4. C40, Organic Impurities in Fine Aggregate for Concrete.

5. C85, Cement Content of Hardened Portland Cement Concrete.

6. C88, Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.

7. C94, Standard Specifications for Ready-Mixed Concrete.

8. C131, Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

9. C136, Method for Sieve Analysis to Fine and Coarse Aggregate.

10. C143, Slump of Portland Cement Concrete.

11. C150, Standard Specification for Portland Cement.

12. C156, Water Retention by Concrete Curing Materials.

13. C173, Air Content of Freshly Mixed Concrete by the Volumetric Method.

14. C231, Air Content of Freshly Mixed Concrete by the Pressure Method.

15. C233, Standard Method of Testing Air-Entraining Admixtures for Concrete.

16. C260, Standard Specifications for Air-Entraining Admixtures for Concrete.

17. C289, Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).

18. C441, Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction.

19. C457, Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete.

20. C494, Standard Specifications for Chemical Admixtures for Concrete.

21. C670, Preparing Precision Statements for Test Methods for Construction Materials.

22. C803, Penetration Resistance of Hardened Concrete.

23. E96, Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

24. E1745, Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

C. Comply with building code requirements which are more stringent than the above and all OSHA requirements.

1.5 QUALITY ASSURANCE

A. Workmanship

The CONTRACTOR is responsible for correction of concrete work that does not conform to the specified requirements, including strength, tolerances, and finishes. Correct deficient concrete as directed by the OWNER or ENGINEER. The CONTRACTOR shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

B. Concrete Testing Service

The OWNER or a representative of the OWNER will engage a special inspector/testing laboratory to perform material evaluation tests and to design concrete mixes. See detailed requirements in Part 3.14 “Quality Control Testing during Construction”. Per the OWNER or ENGINEER’s requirements the CONTRACTOR shall notify the designated representative to schedule the special inspections and materials testing required by the project documents.

C. Testing Requirements

Materials and installed work may require testing and retesting, as directed by the OWNER or ENGINEER, at anytime during the progress of the work. Allow free access to material stockpiles and facilities at all times.

The costs for preparation of mix designs (if required by the OWNER to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the OWNER, except when materials do not meet specified requirements, in which case such costs shall be borne by the CONTRACTOR.

D. Tests for Concrete Materials

1. Test aggregates by the methods of sampling and testing of ASTM C33.

2. For Portland cement, sample the cement and determine the properties by the methods of test of ASTM C150.

3. Submit written reports to the OWNER and ENGINEER, for each material sampled and tested prior to the start of work. Provide the project identification name and number, date of report, name of CONTRACTOR, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

4. Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing. The materials producer and the CONTRACTOR must sign certificates of compliance.

E. Allowable Tolerances:

1. Construct formwork to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 347, and as follows:

   a. Variation from plumb in lines and surfaces of columns, piers, walls and rises; 1/4-inch per 10 feet, but not more than 1-inch. For exposed corner columns, control joint grooves, and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum; 1/2-inch maximum in 40 feet or more.

   b. Variation from level or grade in slab soffits, ceilings, beam soffits, and rises 1/4-inch in 10 feet, 3/8-inch in any bay or 20 feet maximum, and 3/4-inch in 40 feet or more. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum and 1/2-inch in 40 feet or more.

   c. Variation from position of the linear lines and related columns, walls, and partitions, 1/2-inch in any bay or 20 feet maximum, and 1-inch in 40 feet or more.

   d. Variation in sizes and locations of sleeves, floor openings, and wall openings, 1/4-inch.

   e. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls, minus 1/4-inch and plus 1/2-inch.

   f. Variations in footing plan dimensions, minus 1/2-inch and plus two (2) inches; misplacement or eccentricity, two (2) percent of the footing width in direction of misplacement but not more than two (2) inches; thickness reduction, minus five (5) percent.

   g. Variation in steps - In a flight of stairs, 1/8-inch for rise and 1/4-inch for treads; in consecutive steps, 1/16-inch for rise and 1/8-inch for treads.

h. Circular structures shall be constructed in a true circular form, with maximum variation of 1/4-inch from the dimensions shown on the plans.

2. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

3. During concrete placement check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

F. Quality Control Testing During Construction

See Section 3 - Execution.

1.6 CONCRETE MIX DESIGNS

A. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.

B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier or if directed by the ENGINEER, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7, 14 and 28 day strengths versus slump values of two (2), four (4), and six (6) inches, all conforming to these Specifications, shall be established by an approved ready-mix supplier or an independent testing laboratory. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders.

Testing of concrete and materials shall be borne by the OWNER, except when materials do not meet specified requirements, in which case such costs shall be borne by the CONTRACTOR.

C. The exact proportions by weight of all materials entering into the concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the ENGINEER or Laboratory for improved specified strength or desired density, uniformity and workability.

D. The proportions of such mix design shall be based on a full cubic yard of hardened concrete.

E. Ready-mix companies or jobsite batch plants shall furnish delivery tickets, signed by a Certified Weighmaster, on which each shall state the weight of aggregates, sand, cement, admixtures and water and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.

F. There shall be no variation in the weights and proportions of materials from the approved mix design.

G. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.

1.7 READY-MIXED CONCRETE

Ready-mixed concrete shall conform to the requirements of ACI 301 and ASTM C 94. In case of conflict, ACI 301 shall govern.

1.8 SAMPLE

Upon request by the OWNER or ENGINEER the CONTRACTOR shall pour and finish one 2-foot square exposed aggregate concrete sample for ENGINEER's approval prior to construction if exposed aggregate is included on job.

1.9 JOB CONDITIONS

Maintain continuous traffic control and access for vehicular and pedestrian traffic as required for other construction activities as well as to adjoining facilities for regular operation. Utilize flagmen, barricades, warning signs and warning lights as required, to maintain a safe entrance and passage on all roads or drives abutting the project.

PART 2 PRODUCTS

2.1 WALL FORMS

A. Full Height Pours: The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

B. Wall Form Ties

1. Form ties which remain in the wall of a subgrade water-retaining structure shall have waterstops and a 1.5 inch minimum breakback or cone depth.

2. Snap ties, if used, shall not be broken until the concrete has reached the design concrete strength. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.

3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Provide A-58 SURE PLUG as manufactured by DAYTON SUPERIOR or approved equal.

4. Ties shall positively secure the wall to the required dimension and hold the wall to that dimension prior to and during concrete placement.

C. Wall Form Stiffeners

1. Horizontal walers shall consist of structural steel channels, angles or tubing of adequate size to retain the concrete without deflecting.

2. As required the walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacings of no more than 96 inches on center.

3. There shall be at least one such waler within 24 inches of the top and bottom of the wall.

4. The largest dimension of the steel waler shall be in the radial direction.

5. Vertical structural steel or wood members shall be spaced so as to have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.

6. In lieu of the above, a different system and spacings may be used if it is satisfactorily demonstrated to the ENGINEER that it will be equally effective.

2.2 FORMS FOR EXPOSED FINISH CONCRETE

Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Finish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection. Use overlaid plywood complying with U.S. Product Standard PS-1 “B-B High Density Overlaid Concrete Form”, Class I. Use flexible spring steel forms or laminated boards free of distortion and defects to form radius bends as required.

2.3 FORMS FOR UNEXPOSED FINISH CONCRETE

A. Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least two (2) edges and one (1) side for tight fit.

2.4 FORM MATERIALS

A. Form Coatings

Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound. Petroleum based coatings shall not be used for structures in creeks and waterways. Biodegradable coatings shall be used which will not contaminate the creeks/waterways or an alternate method for stripping the form shall be proposed.

B. Chamfers, Reveals, Drips

Provide preformed PVC or shaped wood or metal of size and profile as shown on drawings.

C. Cylindrical Columns and Supports

Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Provide units having “seamless” interior to minimize spiral gaps or seams.

D. Pan Forms

Provide forms for concrete pan-type construction complete with covers and end enclosures to form a true, clean, smooth concrete surface. Design units for easy removal without damaging placed concrete. Block adjoining pan units if required to avoid lateral deflection of formwork during concrete placement and compaction. Provide standard or tapered end forms, as shown.

If required, factory-fabricate pan form units to required sizes and shapes of the following:

1. Steel - 16 gauge minimum, free of dents, irregularities, sag and rust, or

2. Glass-Fiber Reinforced Plastic - Molded under pressure with matched dies, 0.11 inches minimum wall thickness.

E. Inserts & Embeds

Provide metal inserts for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Provide "Parabolt" by the Molly Company, "Phillips Red-Head", "Burke" or approved equal products. The CONTRACTOR is responsible for insuring that all required anchorage not specified in the project documents is installed per current building code and applicable ICC report requirements.

2.5 REINFORCING MATERIALS

A. See Section 03 21 00 – Reinforcing Steel for additional information.

B. Reinforcing Bar (rebar): ASTM A615 or ASTM 706 and as follows below

Stirrups and Ties	Grade 60
All other Uses	Grade 60

C. Supports for Reinforcement

Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise specified. Wood, brick, concrete blocks and other devices will not be acceptable. For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base materials will not support chair legs. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are hot-dip galvanized, after fabrication, or plastic protected or stainless steel protected.

D. Fiber Reinforcement – Collated polypropylene fiber, ¾"-inch, manufactured from 100% virgin homopolymer polypropylene, hydrophobic, in compliance with ASTM C116.

2.6 CONCRETE MATERIALS

A. Portland Cement

ASTM C150, Type II or Type IL (per the limitations listed below unless otherwise acceptable to ENGINEER. Use only one (1) brand of cement throughout the project, unless otherwise acceptable to the ENGINEER. The use of ground granulated blast furnace slag is not allowed.

1. Type IL cement shall only be allowed with an accompanying testing report indicating the surrounding soils sulfate levels are below the following limits:

   a. $SO_4 < 0.10$ water-soluble sulfate (SO_4) in soil percent by mass.

b. SO_4 < 150 dissolved sulfate (SO_4) in water, ppm.

2. Alternatively Type IL cement shall be allowed if the C_3A content of the mix design is less than 8%

B. Aggregates

ASTM C33 and as herein specified. Provide aggregates from a single source for all exposed concrete.

Local aggregates not complying with ASTM C33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the ENGINEER.

1. Fine Aggregate - Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances. Dune sand, bank-run sand and manufactured sand are not acceptable.

2. Coarse Aggregate - Clean, uncoated, processed aggregate containing no clay, mud, loam or foreign matter, as follows:

   a. Crushed stone processed from natural rock or stone.

   b. Washed gravel, either natural or crushed. Use of pit or bank run gravel is not permitted.

   c. Maximum Aggregate Size - Not larger than one-fifth (1/5) of the narrowest dimensions between sides of forms, one-third (1/3) of the depth of slabs, nor three-fourths (3/4) of the minimum clear space between individual reinforcing bars or bundles of bars.

3. These limitations may be waived if, in the judgment of the ENGINEER, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

4. In general it is desired that normal commercial mixes using 1-1/2-inch or 3/4-inch maximum aggregate size be used.

5. Aggregate for exposed aggregate concrete shall consist of selected aggregate of washed clean river gravel in color range of medium to dark in browns and grays; material uniformly sized 5/8-inch to 3/4-inch.

C. Water: Clean, fresh, potable.

D. Air Entraining Admixture: ASTM C260.

E. Water-Reducing Admixture: ASTM C494, Type A or F

F. Set-Control Admixtures: ASTM C494, as follows:

1. Type B, Retarding.
2. Type C, Accelerating.
3. Type D, Water-reducing and Retarding.
4. Type E, Water-reducing and Accelerating.

Calcium chloride will not be permitted in concrete, unless otherwise authorized in writing by the ENGINEER.

2.7 RELATED MATERIALS

A. Joint Sealing Compound: See Section 07 92 00,Sealants and Caulking.

B. Vapor Barrier

C. Provide a vapor barrier over all prepared base material for interior areas. ASTM E1745 Class C polyethylene sheeting, minimum 15 mil thickness with a maximum permeance rating of 0.01 perms per ASTM E96, a minimum puncture resistance of 3000 grams per ASTM D1709 B, and a tensile strength of 70 lbs/in per ASTM E154 Section 9. Provide W.R. Meadows, Inc. Polyolefin Vapor Barrier - Perminator, or approved equal.

D. Form Ties (for forms other than wall forms)

Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal. Unless otherwise shown, provide ties so portion remaining within concrete after removal is at least 1.5 inches inside concrete. Unless otherwise shown, provide form ties, which will not leave holes larger than 1-inch in diameter in concrete surface.

E. Concrete Curing Materials

Concrete curing materials shall be in accordance with ACI 301 Section 5 and ACI 308.1 Section 2.

1. Water-based resin curing compound. W.R. Meadows, Inc. 1100; Euclid Kurez DR VOX; or approved equal.

2. Acrylic curing and sealing compound. W.R. Meadows, Inc. CS-309-30, or approved equal.

3. Water emulsion acrylic curing and sealing compound formulated of acrylic polymers of water-based carrier. W.R. Meadows, Inc. VOCOMP-20, Euclid Luster Seal WB, or approved equal.

F. Epoxy Adhesive

For application to wire-brushed and prepared existing concrete to be mated to new concrete.

1. W.R. Meadows, Inc. INTRALOK, Sika Sikadur-32 Hi-Mod, Sika Armatec-100 EpoCem, or approved equal.

2. Apply per manufacturer's recommendations.

G. Chemical-Hardener Finish: Provide W.R. Meadows, Inc. Liqui-Hard or approved equal.

H. Non-slip Aggregate Finish

Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

I. Non-shrink Grout: See Section 03 60 00, Grouting.

2.8 PROPORTIONING NORMAL CONCRETE

A. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with ACI 211.1. All measurements shall be by weight. All concrete admixtures will either be by the same supplier to insure compatibility. If different suppliers are used a memorandum from EACH admixture supplier will be provided stating the compatibility of their product with the other supplier's products.

B. The slump shall be between two inches and four inches when tested in accordance with ASTM Specifications C 143. Variations in the slump range may be allowed by the ENGINEER if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured slump, the maximum allowable water-cement ratios as specified here-in, shall be strictly adhered to.

C. Compressive Strength, Water and Cement Content

Notwithstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements. All concrete except as noted otherwise on the drawings shall have 4,500 psi 28-day compressive strength and a maximum water/cement ratio of 0.45. Up to a maximum of 15% of cementitious material may be fly ash in accordance with ASTM C618. The use ground granulated blast furnace slag is not allowed for any surfaces in contact with potable water.

D. Retarding Densifiers

1. All concrete (as defined in 2.9 below) used for wall construction shall also contain DARATARD-17, as manufactured by Grace Const. Products, Cambridge, MA or MBL-82, as manufactured by Master Builders, Cleveland, OH in the amounts recommended by the additive manufacturer whenever the air temperature during the pour exceeds 85° F.

2. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride, and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.

3. CONTRACTOR shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

E. Air-Entraining Agents

1. All concrete that that is specified to be air entrained or that may be exposed to freeze/thaw action either during construction or the service life of the structure must be air entrained.

2. Air-entraining agents shall meet ASTM C 260, ASTM C 233 and ASTM C 457.

3. The total volumetric air content of the concrete before placement shall be six (6) percent +/- 1.5 percent as determined by ASTM C 173 or ASTM 231 for mixes using a 3/4"nominal aggregate size.

4. Subject to these Specifications, consideration will be given to the following products: PROTEX “AES,” GRACE “DAREX AEA,” MASTER BUILDERS “MB-AE10,” or SIKA CHEMICAL “AER.”

F. Water Reducing Admixtures

1. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C 494, Type A or D.

2. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.

3. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.

4. Superplasticizers, if allowed by the ENGINEER, shall conform to ASTM C 494, Type F or G, batch plant added using second or third generation only.

5. Set control admixtures if allowed by the ENGINEER, shall conform to ASTM C 494, Type B (retarding) or Type C (accelerating).

2.9 CONCRETE MIXING

A. Ready-Mix Concrete

1. Comply with the requirements of ASTM C94, and as herein specified. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required. When the air temperature is between 85°F and 90°F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is above 90°F, reduce the mixing and delivery time to 60 minutes.

2. Minimum Mix Time: Once all materials are in the drum, the minimum mixing time shall be for 10 minutes before concrete is placed.

PART 3 EXECUTION

3.1 FORMS

A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formworks so concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Design formworks to be readily removable without impact shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms complying with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

E. Erect falsework and support; brace and maintain it to safely support vertical, lateral and asymmetrical loads applied until such loads can be supported by in-place concrete structures.

Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances.

F. Forms for Exposed Concrete

Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes. Do not use metal cover plates for patching holes or defects in forms. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material, which will produce bow. Assemble forms so they may be readily removed without damage to exposed concrete surfaces. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

Corner Treatment - Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines, except as otherwise indicated.

G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings of forms at inconspicuous locations.

H. Chamfer exposed corners and edges, reveals and drips as shown using wood, metal, PVC or rubber strips fabricated to produce uniform smooth lines and tight edge joints. A ½ inch chamfer at exposed edges is typical unless noted otherwise.

I. Provisions for Other Trades - Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such ties. Accurately place and securely support items built into forms.

J. Cleaning and Tightening - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms after concrete placement if required to eliminate mortar leaks.

3.2 PLACING REINFORCEMENT

Detail and place according to ACI Manual SP-66. Unless otherwise noted, minimum cover shall be 1-1/2 inches for No. 5 and smaller bars, 2.0-inches for No. 6 and larger bars or for any bars exposed to exterior or wet environments, and 3.0-inches when poured against earth. Unless otherwise noted, bend all horizontals reinforcing a minimum of two (2) feet at corners and wall intersections.

A. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

B. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.

C. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Do not place reinforcing bars 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.

D. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus two (2) inches, and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.3 JOINTS

A. Construction Joints - Locate and install construction joints not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the ENGINEER. Install and locate other construction joints as specified.

B. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints. Unless otherwise specified, reinforcement shall be lapped in accordance with ACI Standards.

C. Waterstops - Provide waterstops in construction joints as shown on the drawings. Install waterstops to form a continuous diaphragm in each joint. Make provisions to support and protect waterstops during the progress of the work. Fabricate field joints in waterstops in accordance with manufacturer’s printed instructions. Protect waterstop material from damage where it protrudes from any joint.

D. Isolation Joints in Slabs-on-Ground - Construct isolation joints in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated.

E. Control Joints in Slabs-on-Ground - Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4-inch wide by one-fifth (1/5) to one-fourth (1/4) of the slab depth, unless otherwise shown.

1. Form control joints by the following methods

a. Inserting a premolded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured, remove inserts and clean groove of loose debris.

b. Saw cutting a control joint in the required location. Plan for saw cutting so work does not damage reinforcing or violate edge distance minimums.

2. Joint sealant material shall be as specified above.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. General - Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of the items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs - Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.

C. Cast in Place Reglets - Place in straight and continuous lines as detailed to enable flashing to be applied continuously without deviation at reglet joints more than 1/8-inch. Miter corners for continuous reglet joint where outside corners occur. At inside corners extend one section 1-inch past corner. Adequately anchor or secure reglets per manufacturer's instructions prior to pouring and during construction to insure dimensional tolerances and alignment. Vibrate concrete to insure concrete cover adjacent to and around reglet. Visually inspect after pour and patch as required.

3.5 PREPARATION OF FORM SURFACES

Coat the contact surfaces of forms with a form-coating compound before reinforcement is placed. Thin formcoating compounds only with thinning agent of type, and in amount, and under conditions of the form-coating compound manufacturer's directions. Use dissipating-type form oil at surfaces to receive cement plaster finish. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against

which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.6 CONCRETE PLACEMENT

A. Pre-Placement Inspection

1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work as required. Notify ENGINEER in time for inspection prior to pouring.

2. Remove all garbage and debris from the base of formwork. Items such as aluminum cans, food containers, plywood, and their like are to be cleaned-up and disposed.

3. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.

4. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

5. Concrete Curbs and Paving - Do not place concrete until subbase is completed and approved by the ENGINEER as required to provide uniform dampened condition at the time concrete is placed. Moisten subbase as required to provide uniform dampened condition at the time concrete is placed.

B. Place concrete in compliance with the practices and recommendations of ACI 304 and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete, which is being integrated, with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure, which will cause segregation.

2. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.

3. Do not use concrete which becomes non-plastic and unworkable or does not meet the required quality control limits or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the

project site and dispose of in an acceptable location. Do not use concrete whose allowable mixing time has been exceeded.

C. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods, which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.

3. The CONTRACTOR shall provide traffic control on the narrow access roads to the work sites.

4. The CONTRACTOR shall not wash concrete trucks/chutes/equipment off at the project site unless plastic tarps and hay bales are employed to contain the concrete. The CONTRACTOR will be required to haul off-site all concrete contaminated soil.

D. Placing Concrete into Forms

1. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

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

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted.

5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete at least six (6) inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete

embedment of reinforcement and other embedded items without causing segregation of the mix.

6. Do not place concrete in supporting elements until the concrete previously placed in columns and walls is no longer plastic.

E. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment so the concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground, as specified for formed concrete structures. Consolidate concrete in the remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other acceptable methods. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.

4. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

5. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

F. Bonding

1. Roughen surfaces of set concrete at all joints except where bonding is obtained by use of concrete bonding agent, and clean surfaces of laitance, coatings, loose particles and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and not to leave laitance, loose particles of aggregate or damaged concrete at the surface.

2. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:

   a. At joints between footings and walls or columns, and between walls or columns and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.

b. At joints in exposed work; at vertical joints in walls; at joints in girders, beams, supported slabs and other structural members; and at joints designed to contain liquids; dampen, but do not saturate the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.

c. Use neat cement grout consisting of equal parts Portland cement and fine aggregate by weight and not more than six (6) gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16-inch. Deposit fresh concrete before cement grout has attained its initial set.

d. In lieu of neat cement grout, bonding grout may be a commercial bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the bonding material manufacturer.

3. Prepare for bonding of fresh concrete to fully cured hardened concrete or existing concrete by using an epoxy-resin-bonding agent as follows:

a. Handle and store epoxy-resin adhesive binder in compliance with the manufacturer's printed instructions, including safety precautions.

b. Mix the epoxy-resin adhesive binder in the proportions recommended by the manufacturer, carefully following directions for safety of personnel.

c. Before depositing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy-resin grout not less than 1/16-inch thick. Place fresh concrete while the epoxy-resin material is still tacky, without removing the in-place grout coat, and as directed by the epoxy-resin manufacturer.

G. Cold Weather Placing

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

2. When the air temperature has fallen to or is expected to fall below 40°F, provide adequate means to maintain the temperature in the area where concrete is being placed at either 70°F for three (3) days or 50°F for five (5) days after placing. Provide temporary housing or coverings including tarpaulins or plastic film. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. Keep concrete moist. Avoid rapid dry-out of concrete due to over-heating and avoid thermal shock due to sudden cooling or heating.

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

4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

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

H. Hot Weather Placing

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

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

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

4. Wet forms thoroughly before placing concrete.

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

3.7 FINISH OF FORMED SURFACES

A. Rough Form Finish

For formed concrete surfaces not exposed to view in the finish work or covered by other construction, unless otherwise shown or specified. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.

B. Smooth Form Finish

Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view. Or that are to be covered with a coating material applied directly to the

concrete, or a covering material bonded to the concrete such as waterproofing, damp proofing, painting or other similar system.

Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.

C. Curb Finishes

Curbs shall be screeded off accurately to true lines and planes or warped surfaces as indicated or directed. Finish smooth. Arises shall be true and straight or properly eased where curved and neatly rounded with approved tool. Smooth trowel finish with corners rounded to 3/4-inch radius.

D. Grout Cleaned Finish (Sacked)

Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment, and to all exposed to view interior and exterior building surfaces, typical.

Combine one part Portland cement to 1-1/2 parts fine sand by volume, and mix with water to the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

Thoroughly wet concrete surfaces and apply grout immediately to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces

At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.8 MONOLITHIC SLAB FINISHES

A. Float Finish

1. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing or sand bed terrazzo, and as otherwise shown on drawings or in schedules.

2. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4-inch in 10 feet when tested with a 10-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill at low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

B. Trowel Finish

1. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, paint, or other thin-film finish coating system.

2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.

3. Consolidate the concrete surface by the final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in 10 feet when tested with a 10-foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

C. Broom Finish (Non-Slip)

1. Apply non-slip, broom finish to exterior concrete platforms, steps and ramps and elsewhere as shown on the drawings or in schedules.

2. Immediately after trowel finish, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or in the direction of water flow. Use fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the ENGINEER before application.

D. Chemical-Hardener Finish

1. Apply chemical curing-hardening compound or chemical-hardener to all interior concrete floors which will not receive applied finish materials. Mask adjacent work and surfaces to avoid over spray. Apply liquid chemical-hardener after complete curing and drying of the concrete surface.

2. Dilute the liquid hardener with water and apply in accordance with the manufacturer's printed directions. Evenly apply each coat and allow for drying between coats in accordance with manufacturer's printed directions.

3. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

E. Non-slip Aggregate Finish

Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, and elsewhere as shown on the drawings or in schedules.

After completion of float finishing and before starting trowel finish, uniformly spread 25 pounds of dampened non-slip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using steel trowel, but do not force the non-slip aggregate particles below surface. After broadcasting and tamping, apply trowel finish as herein specified. After curing, lightly work the surface with a steel wire brush, or an abrasive stone, and water to expose the non-slip aggregate.

3.9 SCHEDULE OF CONCRETE SURFACE FINISHES

Also see Section 09 90 00, Painting and Coating for protective coating requirements.

Surface Description	Type	Finish Requirement
A. Interior Horizontal Slabs	Slab	Trowel Finish (see Float Finish preparation)

3.10 CONCRETE CURING AND PROTECTION

A. General

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.

2. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for the time period covered in Section 3.10.E and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

B. Curing Methods

Perform curing of concrete by moisture curing (continuous wetting), by moisture-retaining cover curing (damp sand, burlap, canvas, or straw), by liquid membrane curing (liquid membrane-forming compound) or covering concrete with protective

sheet materials (polyethylene plastic sheeting “visqueen” or similar) or by combinations thereof, as herein specified. Provide the curing methods indicated as follows:

1. For concrete floor slabs provide moisture curing, moisture cover curing or liquid membrane/chemical curing-hardening curing. If liquid membrane curing is used, it must be compatible with concrete hardening compounds to be applied later.

2. For other concrete work, provide moisture curing, moisture-retaining cover curing, membrane curing, or protective sheet covering. Do not use liquid membrane or chemical curing-hardening curing on any concrete work to receive any applied finishes.

3. Inspect concrete, regardless of current method selected, do not permit the concrete to become surface-dry at any time. For formwork left in place, ensure the wood formwork is wetted throughout the curing process.

4. For curing, use only water that is free of impurities, which could etch or discolor exposed, natural concrete surfaces.

5. Provide moisture curing by any of the following methods:

    a. Keeping the surface of the concrete continuously wet by covering with water.
    b. Continuous water-fog spray.

6. Provide moisture-retaining cover curing by any of the following methods:

    a. Covering the concrete surface with the specified absorptive cover thoroughly saturated with water and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges with a 4-inch lap over adjacent absorptive covers.

7. Provide sheet material cover curing as follows - Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete placed in the widest practicable width with sides and ends lapped at least three (3) inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.

    a. Use minimum 4 mil thickness, clear or translucent polyethylene sheets “visqueen” or similar.

    b. Support sheet material to prevent marking of the concrete surface.

8. Provide liquid membrane curing as follows:

a. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a coat continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat areas, which are subjected to heavy rainfall within three (3) hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.

b. Do not use membrane-curing compounds on surfaces, which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete. Such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the ENGINEER.

9. Curing formed Surfaces - Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

10. Curing Unformed Surfaces

a. Initially cure unformed surfaces, such as slabs, floor topping and other flat surfaces by moist curing, whenever possible.

b. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.

c. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise acceptable to the ENGINEER.

11. Provide liquid curing-hardening compound as follows:

a. Apply to horizontal surfaces when concrete is dry to touch by means of power spray, hand spray or hair broom in accordance with manufacturer's directions.

C. Temperature of Concrete during Curing

1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.

2. When the atmospheric temperature is 80°F, and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements

before the start of concrete placing for the installation wind breaks or shading, and for fog spraying, wet sprinkling or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protections complying with the requirements of ACI 305.

3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete, which exceed 5°F in any one-hour and 50°F in any 24-hour period.

D. Curing Time

1. Cure concrete for the following times

a. ASTM C150 Type I concrete – Cure for 7 days after placement.
b. ASTM C150 Type II and IL concrete – Cure for 10 days after placement.
c. ASTM C150 Type III concrete – Cure for 3 days after placement.
d. ASTM C150 Type IV and V concrete – Cure for 14 days after placement.

2. When permitted by the ENGINEER, curing operations can be ended once the results of two (2) cylinder tests show that the concrete has reached a strength of 85% f'c. However, no less than 3 days of curing shall occur.

E. Protection from Mechanical Injury - During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In - Fill-in holes and openings in concrete structures for the passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.

B. Curbs - Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations - Provide machine and equipment bases and foundations as shown on the drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing the machines and equipment.

3.12 REMOVAL OF SHORES AND FORMS

A. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support the work without excessive stress or deflection.

Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until the concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

B. Formwork not supporting weight of concrete, such as sides of beams, walls, columns and similar parts of the work, may be removed after cumulative curing at not less than 50°F for 24 hours after placing concrete. Providing the concrete is sufficiently hard to not be damaged by form removal operations and provided curing and protection operations are maintained.

C. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in place concrete by testing field-cured specimens representative of concrete location or members.

D. Form facing material may be removed four (4) days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

E. Re-Use of Forms

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use “patched” forms for exposed concrete surfaces, except as acceptable to the Architect.

No forming material will be allowed to be built permanently into exposed visible surfaces.

3.13 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas

1. Repair and patch defective areas with cement mortar immediately after removal of forms but only when directed by the ENGINEER.

2. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter and holes left by tie rods and bolts down to solid concrete but, in no case, to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the ENGINEER.

3. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

4. Fill holes extending through concrete by means of a plunger type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.

B. Repair of Formed Surfaces

1. Repair exposed-to-view formed concrete surfaces that contain defects, which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the ENGINEER. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolt; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.

2. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01-inch wide, cracks or any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.

C. Repair of Unformed Surfaces

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finished unformed surfaces that contain defects, which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so those repairs can be made without damage to adjacent areas.

5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the ENGINEER.

6. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating, or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same material to provide concrete of the same type or class as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

7. Repair single holes not over 1 inch in diameter by the dry-pack method. Groove the top of cracks and cut out holes to sound concrete and clean off dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

8. Repair isolated random cracks per the requirements of Section 03 74 00 Concrete Repair Crack Injection.

9. For repair of existing unformed surfaces, mechanically remove all lose concrete as required to expose sound aggregate. Clean concrete surfaces to achieve a contaminate free, open textured surface. Square cut or undercut perimeter to minimum depth as specified by the repair mortar manufacturer. Remove all lose

concrete around the exposed steel and hand tool or blast clean all portions of rebar with visible rust to near white metal finish. If half of the diameter of the reinforcing steel is exposed, chip out behind the reinforcing to a 1/2-inch minimum depth. Splice new reinforcing steel to existing where corrosion has depleted the cross-section area by 25%. Apply a corrosion inhibitor/primer/bonding agent to all exposed rebar and other steel components and to concrete surfaces to be repaired per manufacturer's requirements, such as Sika Armatec 110 . Apply a polymer-modified, cement-based, repair mortar, trowel applied as specified by the manufacturer, such as Sika MonoTop 615.

10. Repair methods not specified above may be used subject to the acceptance of the ENGINEER.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The OWNER or a representative of the OWNER will engage a special inspector/testing laboratory to perform all tests and to submit test reports to the OWNER, ENGINEER, and the CONTRACTOR.

B. Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:

1. Sampling Fresh Concrete - ASTM C172, except modified for slump to comply with ASTM C94.

2. Slump Test - ASTM 143; one (1) test for each set of compressive strength test specimens. Samples shall be taken at point of discharge.

3. Air Content - ASTM C231, pressure method; one (1) for each set of compressive strength test specimens.

4. Compression Test Specimen - ASTM C31; One (1) Set which consist of a minimum of four (4) standard cylinders to allow for compressive strength testing, unless otherwise directed. If early loading of members or sections is desired by the CONTRACTOR, additional tests cylinders shall be collected for testing. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

5. Concrete Temperature - Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.

6. Compressive Strength Tests - ASTM C39; One (1) Set for each 100 cubic yards or fraction thereof, of each concrete class placed in any one (1) day, OR for each 5,000 square feet of surface area placed, OR as per minimums outlined below.

a. When the frequency of testing will provide less than five (5) Sets of cylinders by which to perform strength tests for a given class of concrete, conduct testing, as follows.

1) For a class of concrete with a total batch size of greater than 500 cubic yards or 25,000 square feet of surface area, collect test Sets as outlined above.

2) For a class of concrete with a total batch size of less than 500 cubic yards or 25,000 square feet of surface area, but greater than 300 cubic yards or 15,000 square feet of surface area, collect four (4) Sets for testing. Two (2) Sets near the beginning of pouring, one (1) Set mid-way through pouring and one (1) Set towards the end of pouring.

3) For a class of concrete with a total batch size of less than 300 cubic yards or 15,000 square feet of surface area, but greater than 50 cubic yards or 2,500 square feet of surface area, collect three (3) sets of testing. One (1) Set near the beginning of pouring, one (1) Set mid-way through pouring and one (1) Set towards the end of pouring.

4) When the total quantity of a given class of concrete is less than 50 cubic yards, and NO anchors are embedded in the concrete, the ENGINEER may waive the strength tests if, in their judgment, adequate evidence of satisfactory strength is provided. Otherwise testing shall occur as outlined in 3.14.B.6.a

b. Testing Procedure: A Set of specimens with yield four (4) cylinders. Therefore, five (5) Sets will yield 20 cylinders, four (4) Sets will yield 16 cylinders, three (3) Sets will yield 12 cylinders, From each set test one (1) cylinder at seven (7) days, test two (2) cylinders at 28 days, and one (1) cylinder shall be retained in reserve for later testing if required. Additional cylinders can be obtained, at the CONTRACTOR's or OWNER's discretion, for testing at alternate times.

c. If required by the building official, perform strength tests of cylinders cured under field conditions. Field cured cylinders shall be taken and molded at the same time and from the same samples as the laboratory cured test cylinders. When the strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

C. Report test results in writing to the ENGINEER and the CONTRACTOR on the same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of CONTRACTOR, name of concrete supplier and concrete mixing truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure,

design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength and type of break for both 7-day tests and 28-day tests.

D. Additional tests - The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the ENGINEER. The testing service shall conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. CONTRACTOR shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

END OF SECTION

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SECTION 03 60 00 - GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to form, mix, place, cure, repair, finish, and perform all other work as required to produce finished grout, in accordance with the requirements of the Contract Documents.

B. Work covered in this Section includes:

1. Patching, grouting, and sealing.
2. Grouting of door frames in CMU wall
3. Grouting for support of plumbing, fire sprinklers, and HVAC equipment
4. Grout for support of mechanical, electrical, and communications equipment
5. Removal of loose and spalling grout and concrete.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete Work.

1.3 SUBMITTALS

A. Certified Test Results: Verifying the compressive strength, shrinkage, and expansion requirements specified herein for grout used around ground supported steel reservoir bases or for grouts as required by the ENGINEER.

B. Manufacturer Technical Data and Strength Test Results: For sack-mix grouts used on minor-structure/systems provide datasheet information verifying the compressive strength, shrinkage, and expansion requirements specified herein for grout used.

C. Manufacturer's Literature: Containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of non-shrink and epoxy grout used in the work.

1.4 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Specifications, codes, and standards shall be as specified in Section 03 30 00, Cast-in-Place Concrete Work and as referred to herein.

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified.

B. Codes and Standards

1. American Society for Testing and Materials (ASTM)

    a. C1084, “Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete”

    b. C109, “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)”

    c. C191, “Standard Test Method for Setting Time of Hydraulic Cement”

    d. C131, “Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

    e. C136, “Standard Test Method for Sieve Analysis to Fine and Coarse Aggregate”

    f. C143, “Standard Test Method for Slump of Hydraulic Cement Concrete”

    g. C150, “Standard Specification for Portland Cement”

    h. C488, “Standard Test Method for Pull-Out Strength”

    i. C531, “Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes”

    j. C579, “Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes”

    k. C827, “Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures”

    l. C827, “Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures”

    m. C882, “Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear”

    n. C939, “Standard Test Method for Flow of Grout for Preplaced – Aggregate Concrete (Flow Cone Method)”

    o. C942, Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory “”

    p. C1090, “Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic Cement Grout”

q. C1107, “Standard Test Method for Packaged Dry, Hydraulic Cement Grout (Non-Shrink)”

r. C1437, “Standard Test Method for Flow of Hydraulic Cement Mortar”

s. E488, “Standard Test Method for Strength of Anchors in Concrete and Masonry Elements”

2. American Concrete Institute (ACI)

a. “Guide to Hot Weather Concreting”, ACI 305R.

b. “Guide to Cold Weather Concreting”, ACI 306R.

c. “Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces”, ACI 320.2R, as supplemented and modified herein.

3. CRD-C 621, Corps of Engineers Specification for Non-Shrink Grout

1.5 DELIVERY HANDLING AND STORAGE

A. Deliver products in original packaging, labeled with product identification, manufacturer, batch number and shelf life.

B. Handle products in accordance with manufacturer’s printed recommendations. Do not place grout when temperature or humidity will affect the performance or appearance of the grout.

C. Store products in a dry area. Protect from direct sunlight.

D. Do not place grout on dirty, wet, or frozen substrates.

PART 2 PRODUCTS

2.1 PREPACKAGED GROUTS

A. High Strength Non-shrink grout: This type of grout is to be used wherever grout is required in the Contract Documents unless another type is specifically referenced.

1. High Strength Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation of each type of non-shrink grout specified herein shall be that recommended by the manufacturer for the particular application.

Early Height Change, ASTM C827	0.0 to +0.3%		
Hardened Height Change, ASTM C1090	+0.2 to +0.4%		
Effective Bearing Area	95%		
Compressive Strength, ASTM C942	Plastic	Flowable	Fluid
1 Day (min.)	1,000 psi	1,000 psi	1,000 psi
28 Days (min.)	5,000psi	5,000psi	5,000psi
Bond Strength, ASTM C882			
28 Days	2000psi		
Application Temperature	40°F to 90°F		
Material Temperature	40°F to 90°F		

B. General Purpose Non-Shrink Grout shall have minimum 28-day compressive strength of 2500 psi when tested and meet the shrinkage and expansion requirements listed for high strength non-shrink grout.

C. Application

1. High Strength Non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under the exterior rim of the steel tank and all equipment base plates, and at all locations where grout is specified in the contract documents.

2. General Purpose Non-Shrink Grout shall be used for non-structural, non-repair interior or exterior grout applications.

2.2 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where “dry pack” is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

B. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed four (4) inches.

2.3 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers approved by the ENGINEER. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as specified by the manufacturer. The finish of the grout surface shall match that of the adjacent concrete.

B. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the ENGINEER.

3.2 GROUTING PROCEDURES

Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution of prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

3.3 Installation

A. Examination

1. Examine substrates and conditions under which materials will be installed. Do not proceed with Installation until unsatisfactory conditions are corrected.

2. Coordinate installation with adjacent work to ensure proper sequence of construction. Protect adjacent areas landscaping from contact due to mixing and handling of materials.

B. Surface Preparation

Comply with manufacturer's printed instructions and the following:

1. Mechanically remove all unsound concrete to the limits indicated on the drawings. Remove cement paste and laitance to expose sound aggregate.

2. Clean surface to receive grout of all materials including dust, oil, dirt, and grease or Efflorescence.

3. Dampen with clean water before patching and remove standing water.

C. Specialized Installation Requirements

1. Grout Below Bearing Plates:

a. Support bearing plates above cleaned bearing surfaces with double-nutted anchor bolts or wedges.

b. Fill space below bearing plates supporting structural members and stationary equipment with non-metallic non shrink grout.

c. Fill space below bearing plates supporting vibrating equipment with metallic non shrink grout.

2. Grout in Steel Bollards:

a. Fill steel bollards with non-metallic non shrink grout.
b. Smooth trowel grout to 1-inch-high convex curve at top of bollards.

3. Grout in Steel Door Frames: Install non-metallic non shrink grout between masonry rough opening and door frames in masonry walls, fully filling frames with grout.

D. Formwork:

1. Comply with manufacturer's printed instructions and the following:

a. Forms must be watertight, strong, properly braced, and properly coated.

b. Allow a minimum clearance of 2 inches between forms and baseplate for grout entry.

c. Allow a minimum grout head of 6 inches.

d. Slope form on placing side to assist in grout movement and to prevent trapping air.

e. Allow 1-inch horizontal clearance and 1-inch vertical clearance for height above bottom of baseplate.

f. Provide venting of forms to avoid entrapment of air.

E. Mixing Requirements:

1. Comply with manufacturer's printed instructions and the following:

a. Do not re-temper with additional water.

F. Placement of Grout Materials:

1. Comply with manufacturer's printed instructions and the following:

a. The area to be grouted should be thoroughly flushed and soaked with clean water prior to grouting. Leave no standing water.

b. Place the grout quickly and continuously use light rodding or strapping to eliminate air bubbles.

c. Place grout mixture into prepared areas from one side or the other, rapidly and continuously, to reduce air entrapment. Avoid placing grout from opposite sides.

d. Grout temperature should be maintained from 50°F to 90°F to achieve specified results. Use cold water in hot weather or hot water in cold weather to achieve desired grout temperature. Do not use if temperature is expected to go below 32°F within a 12-hour period.

G. Curing Requirements:

1. Utilize a damp cure of at least 3 days is necessary to control the Non-Shrink characteristics and maintain strength levels.

2. Cover fresh grout and anchoring cement with plywood where exposed to construction traffic for 24 hours minimum.

H. Cleaning After Grout Placement

1. Remove excess material before material cures. If material has cured, remove using mechanical methods that will not damage substrate.

3.4 Completion

A. Adjusting Defective Work: Replace or patch grout and anchoring cement as directed by OWNER/ENGINEER/ARCHITECT

END OF SECTION

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SECTION 04 05 17 - MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.1 SCOPE

A. This Section includes all labor, materials and equipment required to complete masonry mortar and grout work required by the Contract Documents including, but not limited to, these major items:

1. Installation
2. Grouting.
3. Placement of vertical and horizontal reinforcing.
4. Cleaning of masonry.

B. Section Includes:

1. Masonry Grout.
2. Mortar.
3. Admixtures.
4. Masonry cleaners.

C. Related Sections:

1. Section 03 30 00 – Cast-in-Place Concrete Work
2. Section 03 21 00 – Reinforcing Steel
3. Section 04 22 00 – Concrete Masonry Units

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

2. ASTM C204 - Standard Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus.

3. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.

4. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

5. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.

6. ASTM C476 - Standard Specification for Grout for Masonry.

1.3 SUBMITTALS

A. Masonry Grout design: Indicating type and proportions of the ingredients according to the proportion requirements herein and ASTM C 476.

1. In lieu of Masonry Grout design, submit the mix designs and grout strength test performed in accordance with ASTM C 476.

B. Mortar design: Indicating type and proportions of ingredients in compliance with the proportion specification herein and ASTM C 270.

1. In lieu of mortar design, submit the mix design and mortar tests performed in accordance with the property specification of ASTM C 270.

C. Color samples for OWNER selection of mortar color.

D. Material certificates certifying each material is in compliance for all Mortar and Grout materials and admixtures.

E. Construction procedures for Cold Weather Construction and/or Hot Weather Construction.

1. Adhere to the procedures and general practices provided for cast-in-place concrete in Section 03 30 00 Cast-in-Place Concrete Work

2. Implement Cold or Hot Weather general practices for the conditions listed in Section 1.4.E.1 and 2 of this Specification

F. Masonry Cleaner: Product information

1.4 QUALITY ASSURANCE

A. Testing Service -- The OWNER will engage an independent testing laboratory to perform material evaluation tests and to perform required Special Inspections.

B. Materials and installed work may require testing and retesting, as directed by the OWNER or ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. All initial testing required by the Contract Documents shall be done at the OWNER's expense. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

C. Minimum Testing Frequency:

1. An independent testing agency or laboratory shall make test specimens of masonry grout and mortar on job site.

2. One mortar test and one grout test shall be taken for each 5,000 square feet of wall area but at least one set of tests shall be taken.

3. The use of testing and inspection does not relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.

D. Inspection Criteria:

1. Masonry construction shall be inspected and evaluated in accordance with the requirements of Chapter 17 of the Oregon Structural Specialty Code, per TMS 402/ACI 530/ASCE 5 Table 1.19.3 – Level 3 Quality Assurance and TMS 602/ACI 530.1/ASCE 6, Table 5 – Level 3 Quality Assurance requirements (ACI 530 Table 1.19.1, Table 1.19.2, & Table 1.19.3), unless otherwise indicated.

2. The Contract Documents shall dictate the required level of inspection per above reference or provide a project specific special inspection program.

3. If the Contract Drawings do not specify the level of required inspection, provide Level 3 Quality Assurance, or obtain written direction from the ENGINEER to the required level of inspection.

E. Environmental:

1. The cold weather construction provisions of ACI 530.1/ASCE6/TMS 602, Article 1.8 C shall be implemented when the ambient temperature falls below 40 degrees F or the temperature of the masonry units is below 40 degrees F.

2. The hot weather construction provisions of ACI 530.1/ASCE 6/TMS 602, Article 1.8 D shall be implemented when the ambient temperature exceeds 100 degrees F or when the temperature exceeds 90 degrees F and the wind velocity is greater than 8 mph.

3. No salt, anti-freeze chemicals or related materials permitted. Store masonry units and bagged materials off ground and protect from rain.

4. Do not build on work having film of water or frost on surfaces.

5. Protect work by covering in rainy weather; protect green masonry from freezing.

6. Before stopping work for day, cover tops of walls at new work with non-staining waterproof covering extended 2 feet minimum down both sides of wall and secured.

F. Delivery, Storage and Handling – Deliver and store packaged materials in original, unopened containers and store in dry weathertight enclosures. Stockpile and handle

aggregates to prevent segregation and contamination. Maintain sand for volume proportioning of mortar and grout in a damp loose condition.

PART 2 PRODUCTS

2.1 MORTAR AND GROUT MATERIALS

A. Cement: Type I Portland cement conforming to ASTM C150.

B. Fine and coarse aggregate: ASTM C404 for grout.

C. Sand:

1. Clean, sharp, well graded, and free from salt, loam, clay, and other foreign matter.

2. Sand shall conform to ASTM C144 for mortar.

3. Sand shall be graded as follows:

Sieve Size	Percent Passing
4	100
8	95 – 100
16	70 -100
30	40 – 75
50	15 – 35
100	2 – 15
200	0

D. Lime: Hydrated type conforming to ASTM C207, Type S.

E. Water: Clean, fit for drinking (potable), and free from strong acids, alkalis, oils, or organic material.

F. Waterproofing admixture: Powder.

1. Type: Grace Hydratite Plus, CemMaster Hydrolox 400, BASF Rheomix, BASF Rheopel or approved equal.

G. Accelerator or retardant

1. May be added when required by weather conditions.

2. Type: Anti-Hydro, Grace Dehydratine 80 or Dehydratine 80M, BASF Pozzolith, Sika Plastiment, Sonneborn Sonotard, Trimex, or approved equal.

H. Intrusion (water-reducing) admixture for masonry grout.

1. Type: BASF Pozzolith, IntrusionAid or approved equal.

I. Water-reducing admixture for mortar.

1. Type: BASF Rheomix or approved equal.

J. Mortar Color.

1. Pure natural finely milled inert water insoluble non-bleeding and free of deleterious fillers or extenders.

2. Color shall be as shown on the Drawings.

3. Color shall be selected by OWNER from manufacturer's standard range of colors.

2.2 PROPORTION OF MIXES

A. Mortar

1. Conform to ASTM C270 and be of the type and color specified.

2. Type S with minimum 28-day compressive strength of 1,800 psi minimum.

3. Mixed by volume in ratio of 1-part Portland cement (6 sacks per cubic yard minimum), 1/4 to 1/2-part lime, 2-1/4 to three (3) parts (to cement-lime combined volume) sand.

4. Pointing mortar shall be one part cement, 1/4 lime, three (3) parts sand by volume. Add one (1) pound of water-reducing admix for mortar per bag of cement and one pound per cubic foot of lime.

5. Add waterproofing in amounts recommended by manufacturer, 0.2 pounds of waterproofing per 100 pounds of cement minimum.

6. Do not use admixtures containing more than 0.2 percent chloride ions.

7. Limit the maximum percentage of mineral oxide or carbon black job site pigments by weight of cement as follows: For pigmented Portland cement-lime mortar; 10 percent maximum mineral oxide pigment or 2 percent maximum carbon black pigment.

B. Masonry grout

1. Conform to ASTM C476.

2. Minimum 28 days compressive strength greater than or equal to 2,500 psi, seven (7) sacks of cement minimum per cubic yard.

3. Waterproofing admix and intrusion admix in amounts recommended by manufacturer, 0.2 lb. of waterproofing per 100 pounds of cement minimum.

C. Masonry grout for pouring:

1. Fluid consistency, seven (7) to eight (8) inches slump.

2. Accurately mix by volume 1-part Portland cement: two (2) parts minimum to three (3) parts maximum of damp loose sand: two (2) parts maximum of 3/8-inch minus aggregate.

3. For masonry grout spaces less then three (3) inches in any dimension, omit 3/8-inch minus aggregate.

D. Masonry grout for pumping:

1. Without segregation of the constituent parts.
2. Mixed to a consistency that has a slump between eight (8) to eleven (11) inches.

E. Empty bags for waterproofing and intrusion admixes shall be retained for verification prior to their disposal. Use accelerator or retardant in strict accordance with manufacturer's printed instructions.

2.3 MASONRY CLEANER

A. Sure Kleen #101 Lime Solvent or approved equal.

PART 3 EXECUTION

3.1 MIXING

A. Masonry grout shall be plant batched.

B. Mortar:

1. All tools and equipment used in mixing of mortar shall be clean and free of contaminants.

2. Measure materials by volume or equivalent weight, not by shovel.

3. Supply only as much water as necessary to obtain desired workability; required compressive strength must be met.

4. Mix by placing 1/2 of the water and sand in the operating mixer. Then add the cement, lime and the remainder of the sand and water.

5. After all ingredients are in the batch mixer, they shall be mechanically mixed for not less than three (3) minutes.

6. Hand mixing shall not be employed.

7. Heat aggregates when air temperature is below 32 degrees F to maintain mortar at 70 to 120 degrees F until used.

8. Maintain workability of mortar by retempering.

    a. Retemper by adding only as much water as required to maintain high plasticity.

    b. Retempering shall only be done by adding water within a basin formed from mortar on a mortar board and working mortar into water.

    c. Discard all mortar which has begun to stiffen, or which is unused after 2-1/2 hours from the initial mixing.

3.2 INSTALLATION

A. See Section 04 22 00, Concrete Masonry Units.

B. All masonry shall be laid true straight level, plumb and neatly in accordance with the drawings; lay out in advance so that no concrete unit less than eight (8) inches in length occur except where necessary as in reveals, etc.

C. All units shall be saw cut accurately to fit all openings, and for electrical and plumbing work.

1. No plumbing or electrical boxes or conduit shall be placed in any cell or course that contains reinforcing.

2. All cutting shall be done with masonry saw and produce neat and true surface.

D. All units shall be sound, dry, clean, and free from cracks and chips.

E. No construction supports shall be attached to the wall except where specifically permitted by the ENGINEER.

F. Units shall be “air” dry at time of laying.

3.3 REINFORCEMENT

A. Refer to Section 03 21 00, Reinforcing Steel.

B. The following minimum requirements shall be met unless shown otherwise:

1. Provide #5 verticals at four (4) feet maximum on center.

2. Locate two #5 at each jamb of door, window, louver, and other openings and end of walls; run full height of wall. Reinforcement adjacent to openings need not be provided for openings smaller than 16-inches in either the horizontal or vertical direction, unless the spacing of distributed reinforcing is interrupted by such openings.

3. Position one #5 vertical at each wall corner and each wall intersection; run full height of wall.

4. Dowel verticals to foundation with one #5 dowel four (4) feet long minimum per vertical; embed dowel two (2) feet in foundation unless otherwise shown on drawings.

5. Horizontal reinforcement, unless shown otherwise, shall be two #4 rebars in the bond beams which are located at four (4) feet maximum on center and at all floor and roof levels. Bend rebar at corners and intersections, or supply two (2) feet by two (2) feet rebar of same size and number as horizontal reinforcement. Horizontal reinforcement shall be anchored around vertical reinforcing bars with a standard hook at all wall ends, corners, and intersections that are not continuous around the corner or through the intersection. For openings, minimum lintel size and reinforcement shall be two (2) #4 rebars in top and bottom of 16-inch lintel for openings up to six (6) feet span. Lintel reinforcement to extend two (2) feet beyond each side of jamb.

6. Before placing reinforcement remove mud, oil, mills scale, loose rust, ice, and any other coatings from it. Position reinforcement accurately; center in cells unless noted otherwise. Secure against displacement, holding vertical reinforcement firmly in place by means of frames, rebar spacers, or other suitable devices, and place horizontal reinforcement as laying progresses. Vertical bars shall be held in position at the top and bottom and at intervals not exceeding 192 diameters of the reinforcement.

7. Minimum clear distance between longitudinal bars shall be nominal diameter of bar or 1-inch, whichever is larger. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4-inch for fine grout and 1/2-inch for coarse grout. Unless noted otherwise, reinforcing bars and dowels shall be lapped 40 bar diameters or 2-foot six (6) inches minimum, where spliced end shall be separated by 1 bar diameter or wired together.

8. Splice reinforcement only at points shown on Drawings or reviewed shop drawings; any other locations must be specifically reviewed by ENGINEER.

a. Splices in adjacent bars shall be staggered; in horizontal reinforcement of walls separate at least 10 feet longitudinally for bars of same tier.

b. Splices in reinforcement shall be made only at such points and in such a manner that the structural strength of the member will not be reduced.

c. Lapped splices shall provide sufficient lap to transfer the working stress of the reinforcement by bond and shear.

d. Minimum lap shall be 40 bar diameters, where spliced end shall be separated by 1 bar diameter or wired together.

e. Welded or mechanical connections shall develop the full yield strength of the reinforcement.

f. Bond beams shall be continuous around corners.

9. When a foundation dowel does not line up with a vertical core, it shall not be sloped more than one horizontal in six vertical. Dowel shall be grouted into a core in vertical alignment, even though it may be in cell adjacent to cell holding vertical wall reinforcing.

10. Bond beam reinforcement shall be laid continuously on webs of bond beam units. Intersecting masonry walls shall be tied to one another by horizontal reinforcement, unless noted otherwise; where masonry walls intersect with concrete walls, connect with 1/2-inch diameter by 15-inch mechanical bolts in flush shells at bond beams.

11. To allow bonding masonry, clean laitance from top of concrete foundation before proceeding. The stating joint on foundations or slabs shall be laid with full mortar coverage except at the area where grout occurs, which shall be kept free of mortar so that grout is in contact with the foundation slabs.

12. Lay units in regular running bond except where soldier or other coursing is shown on drawings; maintain even module. Corners shall have same masonry bond by overlapping units. Joints shall be uniform throughout all work having same type of masonry units.

13. At running bond, thread vertical reinforcing through alternately overlapping cells. Lay units according to “face and shell” method; provide full mortar coverage on all face shells, and on faces and webs surrounding vertical and horizontal cells to be filled with grout.

14. Do not furrow bed joints. Shove tightly each new unit against existing unit so that mortar bonds well to both.

15. Rock closures into place. Do not pound corners and jambs to fit stretcher units after they are set in position. Remove all excess grout and mortar spilled on masonry units during construction.

16. Dry brush all masonry surfaces at end of each day's work. Stop off horizontal run of masonry by racking back one-half length of unit in each course at end of day's work. Toothing is not permitted. Where fresh masonry joins partially set masonry, remove loose units and mortar clean and then lightly wet exposed surface of set masonry before starting new work.

17. Joints of walls to be covered or furred may be left flush, without tooling. Joints of all walls which are to be exposed shall be tooled when "thumb right" hard mortar is partially set but still sufficiently plastic to bond) with round jointer or bar to produce a dense, slightly concave surface, well bonded at edges. All tooling shall be done with a tool which compacts the excess mortar out of joint rather than dragging it out. Joints which are not tight at the time of tooling shall be raked out, pointed, then tooled. If it is necessary to move to a unit after it has been once set in place, the unit shall be removed from wall, cleaned, and set in fresh mortar. Remove any mortar fins from joint junctions.

18. Unless shown otherwise on drawings, provide 8-inch lintel for concrete masonry openings four (4) feet wide or less and 16-inch lintel for openings greater than four (4) feet wide. Forms and shores for lintels shall be substantial. Brace or tie forms to maintain position and shape. Forms shall be tight with no leakage of mortar or grout. Do no remove forms and shores until masonry has hardened sufficiently to carry its own weight and other temporary loads that may be placed on it during construction, 10 days minimum.

3.4 MASONRY GROUTING

A. Masonry grouting shall be by low lift method.

1. The repetitive construction procedure of erecting a masonry wall to a height not greater than four (5) feet, grouting the wall as required and then repeating this cycle until the top of the wall is reached shall be classified as low-lift grouting. Grout shall be placed while mortar joints are still soft and plastic or the grout spaces shall be cleaned of mortar dropping and protruding mortar joints shall be removed.

B. Cells containing reinforcement or embedded items shall be solidly filled with grout. Before grouting starts, reinforcing steel shall be secured in a place and observed by ENGINEER and inspected by Building Inspector from governmental unit having authority.

C. Vertical cells to be filled shall have vertical alignment to maintain continuous unobstructed cell area. To confine grout to horizontal masonry beams, the tops of

unfilled cell cavities or cores in masonry units under beams shall be covered with metal lath, or special bond beam or lintel units shall be used, or another method may be employed if approved by ENGINEER, building paper shall not be permitted.

D. All bolts, anchors, etc., inserted in walls shall be fully and solidly grouted in place. Embedment shall not be less than 3/4 of the wall thickness, unless otherwise noted.

E. Masonry shall cure at least 24 hours before grouting. Keep clean of mortar and drippings those cavities and cores which are to be grouted. Mortar projections and droppings shall be washed out of spaces and off reinforcing with a jet stream of water.

F. Masonry grout shall be poured in lifts not exceeding five (5) feet. All masonry shall be laid using the Low-Lift grouting method with maximum grout pour heights not to exceed five (5) feet unless otherwise allowed in writing by the ENGINEER. In addition, grout pour heights shall not exceed the maximum grout pour height limits of Table 7 of TMS 602/ACI 530.1/ASCE 6, based upon the minimum grout space dimensions for grouting of cells of hollow units. Lay masonry until location of a bond beam or horizontal lintel beam is reached, but not to exceed the limits of Table 7 of TMS 602/ACI 530.1/ASCE 6, and then grout full the vertical cells required to be grouted and fill the beam or lintel without pause.

G. To ensure complete filling of grout space, consolidate grout at time of pouring by puddling and then reconsolidate by later puddling before the plasticity is lost. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

H. Solid grout hollow metal door and window frames; for all wall openings over two (2) feet wide, solid grout from lintel to floor or roof above in one continuous operation.

I. Place grout within 1 1/2 hour from introducing water in the mixture and prior to initial set.

3.5 MASONRY CLEANING

A. All mortar and grout must be thoroughly set and cured before cleaning. Remove excess mortar or mortar stains or efflorescence; scraping devices shall be nonferrous. Protect all adjacent surfaces, including sash and other corrodible metalwork, from damage by cleaning solvent.

B. Saturate all exposed masonry with water immediately before cleaning, apply solution of cleaner as per manufacturer’s instructions and rinse thoroughly with fresh, clean water immediately after cleaning. Do small sections at a time, working from top to bottom. Repeat as necessary.

C. Tuckpoint any loose or defective mortar joints. At conclusion of masonry work, remove scaffolding and equipment used in work and remove debris, refuse and surplus masonry material.

END OF SECTION

SECTION 04 22 00 - CONCRETE MASONRY UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Work included under this section shall include all materials and perform labor required to execute this work as indicated on the drawings, as specified and as necessary to complete the work, including, but not limited to, these major items:

1. Concrete masonry units.

2. Vertical and horizontal reinforcing and dowels projecting into subsequently placed concrete.

3. Setting of flashing and other work to be embedded in masonry.

1.2 RELATED SECTIONS:

1. Section 03 21 00, Reinforcing Steel.
2. Section 04 05 17, Masonry Mortar and Grout.

1.3 SUBMITTALS

A. Samples -- Before any concrete unit masonry materials are delivered to the job site, submit one sample of each proposed concrete masonry unit.

B. Submit color samples for OWNER selection of concrete masonry unit colors.

C. Material Certificates -- Prior to delivery of concrete masonry materials, anchors, ties, fasteners, and metal accessories to the job site, deliver a letter from the manufacturer of the proposed masonry units, anchors, ties, fasteners, and metal accessories certifying that all such units to be delivered to the job site are in strict conformance with the provisions of this Section.

D. Construction procedures for Cold Weather Construction and/or Hot Weather Construction for review and approval by OWNER in compliance with the requirements herein prior to use on the project.

E. A letter of certification from the Supplier of the materials prior to delivery of the materials to the site to verify f'm according to the Chapter 17 of the International Building Code (IBC).

1.4 QUALITY ASSURANCE

A. Qualifications of Workers

1. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

2. Provide one skilled journeyman mason who shall be present at all times during execution of this portion of the work and who shall personally direct all work performed under this Section.

B. Standards, Specifications and Codes

Comply with the applicable provision of the following codes, specifications and standards to the extent indicated by reference thereto:

1. American Concrete Institute (ACI)
2. American Society of Testing and Materials (ASTM)
3. National Concrete Masonry Association (NCMA)
4. Structural Clay Products Institute (SCPI)
5. American Society of Civil Engineers (ASCE)
6. The Masonry Society (TMS)
7. The International Building Code (IBC)

Comply with building code requirements which are more stringent than the above and all O.S.H.A. requirements.

C. Testing Service -- The OWNER will engage an independent testing laboratory to perform material evaluation tests and to perform required Special Inspections.

D. Materials and installed work may require testing and retesting, as directed by the OWNER or ENGINEER, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. All testing required by the contract documents shall be done at the OWNER's expense. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

E. Inspection Criteria:

1. Masonry construction shall be inspected and evaluated in accordance with the requirements of Chapter 17 of the Oregon Structural Specialty Code, per TMS 402 Table 3.1 – Level 3 Quality Assurance and TMS 602, Table 4 – Level 3 Quality Assurance requirements, unless otherwise indicated.

2. The Contract Documents shall dictate the required level of inspection per above reference or provide a project specific special inspection program.

3. If the Contract Drawings do not specify the level of required inspection the CONTRACTOR shall provide Level 3 inspection or obtain written direction from the ENGINEER to the required level of inspection.

F. Minimum Testing Frequency:

1. An independent testing agency or laboratory shall verify the compressive strength (f'm) of the proposed construction prior to construction and at regular intervals during construction as indicated in the Contract Documents, but at least one test for every 5,000 square feet during construction.

2. The compressive strength (f'm) shall be determined for each wythe of multiwythe walls.

3. Unless specifically directed within the Contract Documents, use the unit strength method specified by TMS 602.

4. The use of testing and inspection does not relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the

1.5 PRODUCT HANDLING

A. Store materials under cover in a dry place and in a manner to prevent damage or intrusion of foreign matter. During freezing weather protect all masonry units with tarpaulins or other suitable material. Store masonry units under covers that will permit circulation of air and prevent excessive moisture absorption. Protect concrete masonry units from wetting.

B. Handle unit on pallets or flatbed barrows.

C. Replacements -- In the event of damage, immediately make all repairs and replacements necessary to the approval of the OWNER and at no additional cost to the OWNER.

D. Reinforcing, metal ties, and anchors shall be protected from contact with soil and water and before being placed shall be free of loose rust and other coatings that will reduce or destroy bond.

E. Environmental Conditions - Implement the following special construction procedures based on the environmental conditions encountered during masonry construction. Failure to maintain the conditions specified below during the construction of masonry work will be just and sufficient cause for such work to be rejected.

1. Cold Weather - The cold weather construction provisions of TMS 602, Article 1.8 C shall be implemented when the ambient temperature falls below 40 degrees F or the temperature of the masonry units is below 40 degrees F. All masonry units and

all work on which new masonry is constructed shall be free of frost, ice, snow, and surface moisture and their temperature shall not be lower than 40 degrees F. Protect green masonry from freezing. No salt, anti-freeze chemicals or related materials are permitted.

2. Hot Weather - The hot weather construction provisions of TMS 602, Article 1.8 D shall be implemented when the ambient temperature exceeds 100 degrees F or when the temperature exceeds 90 degrees F and the wind velocity is greater than 8 mph.

3. Wet Weather - Store masonry units and bagged materials off ground and protected from rain. Do not build on work having a film of water on any surfaces. Protect work by covering in rainy weather. Before stopping work for the day, cover the tops of walls at new work with non-staining, waterproof covering extended 2 feet minimum down both sides of wall and secured in place.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Reference Architectural Exterior Elevations drawing for CMU block type.

B. Unit shall be in modular sizes. Exposed-to-view units in anyone building shall be of the same appearance. The texture of units shall match the approved samples for the types of construction and locations designated on the plans. Units shall not contain iron spots or other substances that will stain plaster or paint.

C. Hollow load-bearing units shall conform to ASTM C90 type 1, Grade N.

D. The composition shall be 50 percent lightweight (pumice) and 50 percent sand. The lightweight aggregate shall conform to ASTM C331 and the sand shall conform to ASTM C33.

E. Minimum compressive strength of all blocks shall be 2,000 psi based on the net area.

F. Maximum water absorption permitted for units at the time of delivery to the job site shall be 13 pounds per cubic foot (13 pcf) of concrete as an average of three units for normal weight aggregate per ASTM C140.

G. Maximum moisture content permitted for standard weight aggregate units at time of delivery shall be 30 percent of total absorption. The tests for moisture content shall be determined from an average of five units per ASTM C140.

H. Maximum linear shrinkage shall not exceed 0.065%. Concrete masonry units shall include lintel, and bond beam units, and special shapes and sizes required to complete the work indicated.

I. Certification required above shall show results of tests made not more than 12 months prior to delivery of concrete masonry units to the job site, shall show compliance with the specified values, and shall certify that the mix design, yield per batch, and curing procedures for the units delivered to the job site will be equal to those submitted for the test.

J. Unit Colors. Pure natural finely milled inert water insoluble non-bleeding and free of deleterious fillers or extenders. Colors shall be as shown on the plans. Colors shall be selected by OWNER from manufacturer's standard range of colors.

2.2 MORTAR AND GROUT

Provide mortar and grout as indicated on the drawings in conformance with the requirements of Section 04 05 17, Masonry Mortar and Grout, of these specifications.

2.3 REINFORCEMENT STEEL

Provide reinforcement steel as indicated on the drawings and in conformance with the requirements of Division 3 of these specifications and of Section 04 05 17, Masonry Mortar and Grout.

2.4 OTHER MATERIALS

All other materials, not specifically described but required of a complete and proper installation of the work of this Section, shall be as selected by the CONTRACTOR subject to the approval of the OWNER.

PART 3 EXECUTION

3.1 INSPECTION

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

Carefully coordinate with all other trades to ensure proper and adequate interface of the work of other trades with the work of this Section.

3.3 INSTALLATION

A. Masonry shall be plumb, true to line, with level courses accurately spaced, and built to thickness and bond pattern indicated. Where no pattern is indicated, masonry shall be laid in running bond pattern. Concrete masonry units shall be dry when laid. Each unit shall be adjusted to final position in the wall while mortar is still soft and plastic. Any unit disturbed after mortar has stiffened shall be removed and re-laid with fresh mortar. Chases shall be built in and not cut in. Chases shall be plumb and shall be minimum one unit length from jambs of openings. Chases and raked-out joints shall be kept from mortar or debris. Spaces around metal door frames and other built-in items shall be solidly filled with mortar as each course is laid. Anchors, wall plugs, accessories, flashings, and other items to be built in shall be installed as the masonry work progresses. All cutting and fitting of masonry, including that required to accommodate the work of other sections shall be done by masonry saws.

B. Where fresh masonry joins masonry that is partially set or totally set, clean the exposed surface of the set masonry, and remove all loose mortar. If it is necessary to "stop off" a horizontal run of masonry, this shall be done by raking back one-half brick or block length in each course. Toothing will not be permitted.

C. Before closing up any pipe, duct or similar inaccessible spaces or shafts with masonry, remove all rubbish and sweep out the area to be enclosed.

D. Provide level and solid bearing in masonry walls under all bearing structural floor and roof elements. Solid bearing shall be bond beams unless otherwise indicated.

E. All masonry walls shall extend to underside of floor beams or roof metal decking unless otherwise indicated.

F. If blowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt at no additional cost to the OWNER.

G. Mortar Beds and Joints

1. Hollow units shall be laid with full mortar coverage on horizontal and vertical face shells, except that webs shall be also be bedded in all courses of the starting course on footings and solid foundation walls, and where adjacent to cells or cavities to be reinforced and/or filled with grout or concrete.

2. Horizontal and vertical face joints shall be 3/8-inch thick unless otherwise indicated. Vertical joints shall be shoved tight. Mortar joints in exposed or painted surfaces shall be tooled when thumbprint hard to a flush joint. Joints in unparged masonry below grade shall be pointed tight with a trowel. Mortar joints in surfaces to be plastered, stuccoed, or covered with other masonry shall be cut flush. Mortar

protrusions extending into cells or cavities to be reinforced and filled shall be removed.

H. Placing Reinforcement

1. Place reinforcing as covered in Section 04 05 17 – 3.3, Masonry Mortar and Grout, of these specifications.

    a. Vertical reinforcement shall be rigidly secured at the top and bottom of CMU wall and at intervals necessary to hold the reinforcing in proper position.

    b. Reinforcement shall be placed at the wall centerline unless indicated otherwise.

I. Low-Lift Grouting

1. Place reinforcing as covered in Section 04 05 17 – 3.4, Masonry Mortar and Grout, of these specifications.

    a. Set steel lintels in beds of mortar. Fill spaces around jambs and head of metal door buck and frames solidly with mortar.

J. Pointing and Cleaning

1. At the completion of the work, all holes in joints of masonry surfaces to be exposed or pointed except weep holes shall be filled with mortar and suitably tooled, masonry walls shall be dry brushed at the end of each day's work and also final pointing, and shall be left clean and free from mortar spots and droppings. Any cracks in masonry shall be repaired. Defective joints shall be cut out and repointed.

2. Remove efflorescence, mortar spots and other areas that appear unclean with cleaning agent to a sample wall area as directed by the OWNER. The OWNER retains the right to change proposed cleaning methods and shall be notified before any additional cleaning agent is used. The cleaning methods agent shall be applied to a small section of the wall at a time and work shall proceed from the top to the bottom. Protect all metal sashes, lintel, louvers, and other corrodible parts when masonry is cleaned.

END OF SECTION

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SECTION 05 50 00 - METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. The extent of metal fabrications work is shown on the Drawings and includes items fabricated from iron, steel, stainless steel and aluminum shapes, plates, bars, sheets, strips, tubes, pipes, and castings which are not a part of structural steel or other metal systems in other sections of these specifications.

1.2 REFERENCE STANDARDS

A. Aluminum Association (AA):

1. AA DAF-45 - Designation System for Aluminum Finishes

B. American Architectural Manufacturers Association (AAMA):

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
3. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

C. American National Standards Institute (ANSI):

1. ANSI A14.3 - American National Standard (ASC) for Ladders - Fixed - Safety Requirements

D. American Welding Society (AWS):

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination
2. AWS D1.1 - Structural Welding Code - Steel
3. AWS D1.6 - Structural Welding Code - Stainless Steel

E. ASTM International (ASTM):

1. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
2. ASTM A36 - Standard Specification for Carbon Structural Steel
3. ASTM A47, grade as selected - Malleable Iron Castings
4. ASTM A48, Class 30 - Gray Iron Castings

5. ASTM A53- Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
6. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
7. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
8. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
9. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications
10. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
11. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
12. ASTM A283, Grade C - Steel Plates to be Bent or Cold Formed
13. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes
14. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
15. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
16. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
17. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
18. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
19. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
20. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing
21. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts
22. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
23. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
24. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

25. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

26. ASTM A992 - Standard Specification for Structural Steel Shapes

27. ASTM B26 - Standard Specification for Aluminum-Alloy Sand Castings

28. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings

29. ASTM B177 - Standard Guide for Engineering Chromium Electroplating

30. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

31. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

32. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire

33. ASTM B 308, Alloy 6061-T6, Anodic Coating Class I, AA-C22-A41, anodized after fabrication - Structural Aluminum Shapes and Plates

34. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

35. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

36. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings

37. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings

38. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength

39. ASTM F436 - Standard Specification for Hardened Steel Washers

40. ASTM F844 - Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

41. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength

F. Builders Hardware Manufacturers Association (BHMA):

1. ANSI/BHMA A156.20 - American National Standard for Strap and Tee Hinges and Hasps

G. National Ornamental & Miscellaneous Metals Association (NOMMA):

1. NOMMA Guideline 1 - Joint Finishes

H. SSPC: The Society for Protective Coatings:

1. SSPC - Steel Structures Painting Manual
2. SSPC Paint 15 - Steel Joist Shop Primer/Metal Building Primer
3. SSPC Paint 20 - Zinc-Rich Coating (Type I - Inorganic and Type II - Organic)
4. SSPC SP 1 - Solvent Cleaning
5. SSPC SP-7 Brush-off Blast Cleaning
6. SSPC SP 10 - Near-White Blast Cleaning

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for Submittals.

B. Manufacturer's Data: For information only, submit copies of Manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal work, including paint products.

C. Shop Drawings:

1. General: Submit copies of shop drawings for the fabrication and erection of all assemblies of miscellaneous metal work which are not completely shown by the Manufacturer's data sheets.

a. Include plans, elevations, and details of sections and connections and fabricators proposed shop coat paint or galvanizing specifications.

b. Show anchorage and accessory items.

c. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, which are to be embedded in concrete construction.

d. Indicate welded connections using standard AWS A2.4 welding symbols.

e. Indicate net weld lengths.

2. Stairs, Handrails, and Railings:

a. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

3. Gratings:

a. Indicate details of gratings, plates, component supports, anchorages, openings, perimeter construction details, and tolerances.

D. Samples:

1. Submit two sets of representative samples of materials, illustrating factory finishes as may be requested by the Owner's Representative.

2. Owner's Representative review will be for color, texture, style and finish only.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Transporting, handling, storing, and protecting products shall be in accordance with Manufacturer's requirements.

B. Inspection: Accept metal fabrications on-site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather or by ground contact.

1.5 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to preparation of Shop Drawings and fabrication. Indicate field measurements on Shop Drawings.

1. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication.

PART 2 PRODUCTS

2.1 GENERAL

A. For the fabrication of miscellaneous metal work items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, roughness and defects which impair strength, durability, and appearance. Remove such blemishes by grinding or by welding and grinding prior to cleaning, treating and application of surface finishes including zinc coatings.

2.2 NOT USED

2.3 BOLLARDS

A. Description:

1. Steel pipe, concrete filled
2. Crowned cap
3. Size: 6-inch diameter, length as indicated on Drawings.
4. Shop Finish: Prime Paint, one coat.

B. Concrete Fill:

1. Minimum Compressive Strength: 3,000 pounds per square inch (psi).
2. As specified in Section 03 30 00, Cast-in-Place Concrete.

C. Anchors: Concealed type as indicated on Drawings.

2.4 ANCHORS

A. All anchors shall be epoxy anchors or expansion anchors as shown in the Drawings.

B. Materials:

1. As shown in the Drawings.

2. For direct bury:

a. Malleable iron complying with ASTM A47
b. Cast steel complying with ASTM A27
c. Iron and steel galvanized in compliance with ASTM A153

3. For wetted atmospheric conditions

a. Type 316 stainless steel

4. Threaded rod, nuts, bolts, and washers:

a. Material matching anchor insert type

C. Types:

1. Threaded-type Concrete Inserts:

a. Internally threaded to receive machine bolts
b. Malleable iron, ASTM A47
c. Cast steel, ASTM A27
d. Stainless steel, type 304, ASTM A320

2. Wedge-type Concrete Inserts:

a. Box-type ferrous castings designed to accept bolts having special wedge-shaped heads.

3. Slotted-type Concrete Inserts:

a. Box-type welded construction with slot designed to receive square head bolt and with knockout cover.

D. Manufacturers:

1. Hilti, Inc.
2. Simpson Strong-Tie Co., Inc.
3. Proprietary products as named in the Drawings.

2.5 NOT USED

2.6 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting systems. Acceptable manufacturers are Simpson or equal.

B. Manufacture or fabricate items of sizes, shapes, and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere furnish galvanized steel washers.

2.7 MISCELLANEOUS FABRICATIONS, FRAMING, AND SUPPORTS

A. Provide miscellaneous steel framing and supports required to complete the Work.

B. Fabricate miscellaneous units to the sizes, shapes and profiles shown in the Drawings or, if not shown, of the required dimensions to receive adjacent grating, plates doors, or other work to be retained by the framing.

C. Except as otherwise shown, fabricate from structural steel shapes and plate and steel bars, all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection.

D. Cut, drill, and tap units to receive hardware and similar items to be anchored to the work.

E. Equip units with integrally welded anchors for casting into concrete, bolting to structural steel or building into masonry. Furnish inserts if units must be installed after concrete is placed.

F. Galvanize all miscellaneous fabrications unless otherwise noted.

2.8 NON-SHRINK GROUT

A. Where required for anchoring, patching, or sealing, grouting, and sealing compounds shall conform to the requirements of Section 03 60 00, Grouting.

2.9 MATERIALS

A. Materials listed below shall be provided unless otherwise noted in the Drawings or other sections of these specification.

B. Steel:

1. Structural W Shapes: ASTM A992

2. Structural Shapes: ASTM A36

3. Channels and Angles: ASTM A36

4. Steel Plate: ASTM A36

    a. Steel Plate to be Bent or Cold Formed: ASTM A283, Grade C

5. Hollow Structural Sections: ASTM A500, Grade B

6. Structural Pipe: ASTM A53, Grade B, Schedule 40 unless shown otherwise in Drawings

7. Bar: ASTM A36

    a. Cold-Finished Steel Bar: ASTM A108, grade as selected by fabricator

8. Sheet Steel: ASTM A653, Grade 33 Structural Quality

9. Tubing: ASTM A513, Type 5, minimum 50 kilopounds per square inch (ksi) yield strength

10. Standard Bolts: ASTM A307; Grade A

    a. Washers: ASTM F844

11. High Strength Bolts: ASTM A325

    a. Washers: ASTM F436; Type 1

12. Nuts: ASTM A563; heavy-hex type

13. Welding Materials: AWS D1.1; type required for materials being welded

C. Stainless Steel:

1. Bars and Shapes: ASTM A276; Type 316
2. Tubing: ASTM A269; Type 316
3. Pipe: ASTM A312, seamless; Type 316
4. Plate, Sheet, and Strip: ASTM A666; Type 316
5. Bolts, Nuts, and Washers: ASTM A354; Type 316
6. Welding Materials: AWS D1.6; type required for materials being welded

D. Aluminum:

1. Structural Aluminum Shapes and Plates: ASTM B308, Alloy 6061, Temper T66, Anodic Coating Class I, anodized after fabrication

2. Aluminum-Alloy-Drawn Seamless Tubes: ASTM B210 Alloy 6063, Temper T6

3. Aluminum-Alloy Bars: ASTM B211 Alloy 6063, Temper T6

4. Bolts, Nuts, and Washers: Stainless steel or Steel, galvanized

5. Welding Materials: AWS D1.1; type required for materials being welded

E. Bolts, Nuts, and Washers for Equipment and Piping:

1. Select fasteners for the type, grade, and class required for the installation of miscellaneous metal items.

2. Carbon Steel:

    a. General: Zinc-coated, ASTM A153
    b. Structural Connections: ASTM A307, Grade 2 (60 ksi), hot-dip galvanized

c. Anchor Bolts: ASTM A307, Grade 2 (60 ksi), hot-dip galvanized
d. Pipe and Equipment Flange Bolts: ASTM A193, Grade B-7
e. High Strength Bolts: ASTM F3125, Heavy Hex Head

3. Stainless Steel: Type 316 stainless steel, Class 2; ASTM A193 for bolts; ASTM A194 for nuts

a. Where stainless steel bolts are in contact with dissimilar metals, glass epoxy insulating sleeves and washers shall be used to electrically isolate the bolts.

2.10 FABRICATION

A. Workmanship:

1. Use materials of the size and thicknesses shown in the Drawings or, if not shown, of the required size and thickness to produce adequate strength and durability in the finished product for the intended use as approved by the Owner's Representative.

2. Work to the dimensions shown in the Drawings or accepted on Shop Drawings, using proven details of fabrication and support.

3. Use the type of materials shown in the Drawings or specified for the various components of work.

4. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

5. Ease exposed edges to a radius of approximately 1/32-inch, unless otherwise shown in the Drawings.

6. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.

B. Fit and shop-assemble items in largest practical sections for delivery to Site.

C. Fabricate items with joints tightly fitted and secured.

D. Continuously seal join members by means of continuous welds in accordance with the recommendations of AWS, unless otherwise noted or approved.

E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

H. Loose Bearing and Leveling Plates:

1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.

2. Drill plates to receive anchor bolts and for grouting as required.

3. Galvanize after fabrication.

I. Miscellaneous Steel Trim:

1. Provide shapes and sizes for profiles shown in the Drawings.

2. Except as otherwise indicated, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges.

3. Use concealed field splices wherever possible.

4. Provide cutouts, fittings, and anchorages as required for coordination of assembly and installation with other work.

J. Fabrication Tolerances:

1. Squareness: 1/8-inch maximum difference in diagonal measurements.
2. Maximum Offset between Faces: 1/16-inch.
3. Maximum Misalignment of Adjacent Members: 1/16-inch.
4. Maximum Bow: 1/8-inch in 48 inches.
5. Maximum Deviation from Plane: 1/16-inch in 48 inches.

2.11 FINISHES

A. Steel:

1. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

2. Do not prime surfaces in direct contact with concrete or where field welding is required.

3. Prime-paint items with one coat, except where galvanizing is specified.

4. Coatings as specified per Section 09 90 00, Painting and Coating.

a. Primer paint selected must be compatible with the required finish coats of paint.

b. At locations in contact with potable water, use only primer approved for potable water use.

5. Galvanizing for Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strips: ASTM A123; hot-dip galvanize after fabrication

6. Galvanizing for Fasteners, Connectors, and Anchors:

a. Hot-Dip Galvanizing: ASTM A153
b. Mechanical Galvanizing: ASTM B695; Class 50 minimum

7. Chrome Plating: ASTM B177, nickel-chromium alloy, polished finish

8. Sheet Steel: Galvanized

9. Bolts: Hot-dip galvanized

10. Nuts: Hot-dip galvanized

11. Washers: Hot-dip galvanized

12. Touchup Primer for Galvanized Surfaces: ASTM A780 (A780M), A1. Repair Using Zinc-Based Alloys (Heat and Stick Method)

B. Stainless Steel:

1. Satin-Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

2. Mirror-Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed.

C. Aluminum:

1. Protection of All Aluminum:

a. Aluminum surfaces in contact with cementitious, masonry or dissimilar materials, apply the following coating system:

1) One (1) coat of epoxy primer, 1 to 2 mils dry film (D.F.).
2) Followed by two (2) coats of Bitumastic, 6 to 8 mils D.F.
3) Followed by two (2) coats of tarset material, 6 to 8 mils D.F.

D. Shop Painting

1. Shop painting of metal fabrications shall be allowed only at the sole discretion of the Owner's Representative.

2. Shop paint miscellaneous metal work in accordance with Section 09 90 00, Painting and Coating, with the following exceptions:

a. Those members or portions of members to be embedded in concrete or masonry.

b. Surfaces and edges to be field welded.

c. Galvanized surfaces.

3. Remove scale, rust, and other deleterious materials before the shop coat of paint is applied.

a. Clean off heavy rust and loose mill scale in accordance with SSPC SP-7, Brush-off Blast Cleaning.

b. Remove oil, grease, and similar contaminates in accordance with SSPC SP-1, Solvent Cleaning.

4. Immediately following surface preparation, brush or spray on metal primer paint, applied in accordance with the Manufacturer's instructions or as specified below.

5. Apply one shop coat of metal primer paint to fabricated metal items, except apply two coats of paint to surfaces which will be inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

E. Touch-up Painting, Pre-painted Items:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of the shop paint, and paint all exposed areas with the same material as used for shop painting.

2. Apply touch-up coatings by brush or spray to provide a minimum dry film thickness of the original coating thickness.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where Site welding is required.

B. Furnish setting drawings, diagrams, templates, instructions, and directions for the installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections. Coordinate delivery of such items to the Project Site.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, and free from distortion or defects.

B. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

D. Fit exposed connections accurately together to form tight hairline joints.

E. Grind joints smooth and touch-up shop paint coat.

F. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

G. Field-weld components indicated on Drawings and Shop Drawings.

H. Perform field welding according to AWS D1.1 with regards to procedures of manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work.

I. Obtain approval of Owner's Representative prior to Site cutting or making adjustments not scheduled.

3.4 TOLERANCES

A. Maximum Variation from Plumb: ¼-inch per story or for every 12 feet in height, whichever is greater, non-cumulative.

B. Maximum Variation from Level: 1/16-inch in 3 feet and 1/4-inch in 10 feet.

C. Maximum Offset from Alignment: 1/4-inch.

D. Maximum Out-of-Position: 1/4-inch.

3.5 FIELD QUALITY CONTROL

A. Welding: Inspect welds according to AWS D1.1.

B. Replace damaged or improperly functioning hardware.

C. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

D. Touch up factory-applied finishes according to Manufacturer-recommended procedures.

3.6 ADJUSTING

A. Adjust operating hardware and lubricate as necessary for smooth operation.

END OF SECTION

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SECTION 06 05 23 - WOOD, PLASTIC, AND COMPOSITE FASTENINGS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for fasteners and adhesives used in the construction of the wood, plastic, and composite elements of the project.

B. Section includes:

1. Rough carpentry hardware.
2. Nails.
3. Bolts and screws.
4. Framing anchors.
5. Joist, rafter, and beam hangers.
6. Adhesives.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough Carpentry.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer’s data on all materials.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer’s handling, delivery, storage, and installation requirements.

PART 2 PRODUCTS

2.1 ROUGH CARPENTRY HARDWARE

Rough carpentry hardware used in building construction shall conform to the latest provisions of the Oregon State Structural Specialty Code, the International Building Code (IBC), and to any local codes and ordinances.

2.2 NAILS

A. Steel Common Nails: For framing, appropriately sized for the materials being joined.

B. Hot-Dipped Galvanized Nails: Wherever exposed.

C. Stainless Steel Nails: At locations where stainless-steel hardware is specified. Do not mix dissimilar materials without approval of the ENGINEER.

D. Treated Wood: Hot-dipped galvanized or stainless-steel nails are required at all locations where they are in contact with treated wood.

E. The number and size of nails connecting wood members shall be per the Contract Documents but shall not be less than that set forth in Table 2304.10.1 of the IBC for any members.

2.3 BOLTS AND SCREWS

A. Conforming to ASTM A307, Grade A, appropriately sized for the materials being joined.

B. Use galvanized bolts and screws where exposed or in contact with treated wood or embedded into concrete.

2.4 FRAMING ANCHORS & JOIST, RAFTER AND BEAM HANGERS

A. Use galvanized, minimum 18-gauge steel of the size and type required for the materials connected.

B. Post hot-dip galvanize all connection hardware in contact with pressure treated wood, or use stainless steel connectors.

C. Manufacturers:

1. Simpson “Strong-Tie”.
2. Teco “MiTek” with approved ICC Testing Documentation.
3. Approved equal.

2.5 ADHESIVES

Use gun grade adhesive suitable for bonding various metals and non-metallic materials such as wood, plastic, and glass without primer.

PART 3 EXECUTION

3.1 GENERAL

A. Use only skilled workers and the highest standards of the craft.
B. Lay out, cut, fit, and install all rough carpentry items.
C. Anchor sufficiently to ensure rigidity and permanence as noted on the Drawings.

END OF SECTION

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish materials, labor, equipment, and services necessary to provide rough framing as shown on the Drawings and as specified herein.

B. Section includes:

1. Lumber.
2. Plywood.
3. Building paper.

1.2 RELATED SECTIONS

A. Section 06 05 23 - Wood, Plastic, and Composite Fastenings.

1.3 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Submit a complete list of products, product information, type, and grade for prior to beginning building construction.

1.4 QUALITY ASSURANCE

A. All work specified herein shall conform to the latest provisions of the International Building Code (IBC), the Plastic Lumber National Evaluation Service, NER-508, and the local Codes and Ordinances of all Governmental agencies having jurisdiction over the Project.

B. Where special inspection of wood structural elements is required in the Contract Documents, an independent testing agency or laboratory shall perform special inspection of the elements indicated in the Contract Documents. The OWNER or an agent of the OWNER will engage a testing laboratory acceptable to the ENGINEER to perform the required Special Inspections and/or Material Tests.

C. Materials and installed work may require testing and retesting, as directed by the ENGINEER, at any time during the progress of the work.

1. Allow free access to material stockpiles and facilities at all times.

2. All testing required by the contract documents shall be done at the OWNER'S expense.

3. Testing expenses for the retesting of rejected materials and installed work will be charged back to the CONTRACTOR.

1.5 DELIVERY, HANDLING AND STORAGE

A. Immediately upon delivery to Site, place materials in an area protected from weather.

B. Store materials a minimum of six (6) inches above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Do not store seasoned materials in wet or damp portions of building.

D. Protect sheet materials from breaking corners and damaging surfaces while unloading.

PART 2 PRODUCTS

2.1 MATERIALS

A. Lumber grading rules and wood species shall be in conformance with the latest edition of U.S. Department of Commerce, National Institute of Standards and Technology, Product Standard DOC PS 20 and the National Forest Products Association.

B. Wood members shall conform to the requirements above and provide design values equal to those published in the "Design Values for Wood Construction," a supplement to the 2015 edition of the National Design Specification for Wood Construction, published by the National Forests Products Association.

C. Plywood grading rules shall be in conformance with the latest edition of U.S. Product Standards PS 1 and PS 2, and be Engineered Wood Association (APA) rated Exposure 1.

D. Lap siding, soffit panels and trim shall be as specified in Section 07 42 13, Metal Wall Panels and 07 60 00, Flashing and Sheet Metal of these Specifications.

2.2 GRADE MARKS

A. Each piece of lumber shall be stamped or branded with the grade as determined by an approved grading association indicating conformance with the latest edition of U.S. Product Standard DOC PS 20.

B. Each panel of plywood shall be identified with the appropriate grade trademark of the American Plywood Association.

C. Moisture content shall not exceed 19 percent, unless otherwise specified.

2.3 LUMBER

A. Dimensions given are nominal. Surface four sides (S4S), unless specified otherwise.

B. Unless otherwise noted, lumber shall be as follows:

Use	Minimum Grade
General framing, studs, plates, blocking, furring, braces and nailers	Douglas Fir-Larch No. 2
Structural joists, rafters, and planks, two (2) inches to four (4) inches thick, five (5) inches and wider and headers	Douglas Fir-Larch No. 2
Fascia Board	Fiber cement board manufactured by James Hardie or approved equal
Sills and Plates	Douglas Fir-Larch No. 2, Treated in accordance with IBC 2303.1.9

2.4 PLYWOOD

A. Roof Sheathing:

1. Conform to APA-rated sheathing and shall be identified with the appropriate trademark.

2. Minimum sheathing shall be Exposure 1, 1/2-inch or greater, grade CDX. Span rated 32/16 per APA.

B. MDO -- APA rated Medium Density Overlay exterior glue.

2.5 BUILDING PAPER

A. Asphalt-saturated felt conforming to ASTM D 226 or D 250, Type I, plain non-perforated.

PART 3 EXECUTION

3.1 GENERAL

A. Use only skilled workers and the highest standards of the craft.

B. Plan work in advance and perform in proper sequence to facilitate prompt and continuous progress of the work.

C. Lay out, cut, fit, and install all rough carpentry items.

D. Anchor sufficiently to ensure rigidity and permanence and as noted on Drawings.

E. Provide for installation and support of other work.

3.2 CONDITIONS OF SURFACES

A. Verify that surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

3.3 INSTALLATION

A. Plates

1. Set level and flush with outside face of concrete or masonry unit walls or as shown on the Drawings.

2. Anchor into concrete or masonry unit walls with specified anchors.

3. Location and spacing of plate anchorages shall be as shown or if not shown in conformance with current local building codes.

B. Stud Framing

1. Plates and Stud Members

a. Unless shown otherwise in the Drawings, provide pressure treated double top plates, 1-1/2 inches thick by 7-1/4 inches wide (2 x 8). Provide double top plates for the tops of the wood framed interior partition wall, 1-1/2 inches thick by 5-1/2 inches wide (2 x 6). Splice top plates at corners and intersections with an appropriate framing anchor as specified in Section 06 05 23. Stagger top plate laps by a minimum of 4 feet.

b. Provide pressure treated sill plates, 1-1/2 inches thick by 5-1/2 inches wide (2 x 6) for the tops of all masonry unit stem walls or concrete slabs. Anchor sill plates as specified in Section 06 05 23.

c. Provide studs in continuous lengths without splice.

d. End nail studs to bottom plate and end nail to lower top plate where required.

e. Facenail upper top plate to lower top plate.

f. Anchor plates to concrete or CMU walls as shown on Drawings.

2. Blocking

    a. Install continuous, staggered horizontal row where shown on Drawings or required by code.

    b. Locate blocking to facilitate installation of finishing materials, fixtures, specialty items, hardware, and trim.

C. Roof Sheathing

1. Install plywood with face grain perpendicular to supports, using panel with continuous end joints over two or more spans staggered between panels and locate over supports.

2. Allow minimum space 1/16-inch (1.6 mm) between end joints and 1/8-inch at edge joints for expansion and contraction of panels.

3. Support edge joints by use of ply clips or lumber blocking, unless noted otherwise on Drawings.

D. Ceiling Plywood

1. Install ceiling plywood where shown on Drawings with joints transverse to the members they attach to.

2. Attach plywood sheets to wood framing using finish nails.

3. Countersink nails.

4. Spackle and sand joints, knot holes, and nail holes as required to provide a smooth uniform surface prior to application of paint coating system as specified in Section 09 90 00, Painting and Coating.

E. Lap Siding: Install horizontal lap siding as required by manufacturer recommendations.

F. Fastener Requirements:

1. Connections for wood members shall be in accordance with the Contract Drawings and Section 06 05 23, Wood, Plastic, and Composite Fastenings.

2. The number and size of nails connecting wood members shall not be less than that set forth in Table 2304.10.1 of the IBC.

END OF SECTION

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SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Board insulation over roof deck.

1.2 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2017.

B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation 2019.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2020.

F. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C 2019a.

1.3 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures for submittal procedures.

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

1.4 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. Insulation Over Roof Deck: Polyisocyanurate board.

2.2 FOAM BOARD INSULATION MATERIALS

A. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.

1. Type and Compressive Resistance: Type VI, 40 psi (276 kPa), minimum.

2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.

3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.

4. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88) per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.

5. Manufacturers:

a. Dow Chemical Company; STYROFOAM HIGHLOAD 40: www.dowbuildingsolutions.com/#sle.

b. Kingspan Insulation LLC; GreenGuard XPS Type IV, 25 psi: www.kingspan.com/#sle.

c. Owens Corning Corporation; FOAMULAR Extruded Polystyrene (XPS) Insulation: www.ocbuildingspec.com/#sle.

d. Or Approved Equal.

2.3 BATT INSULATION MATERIALS

A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.

B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.

1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.

2. Thermal Resistance: R-value (RSI-value) as shown on drawings.

3. Manufacturers:

a. CertainTeed Corporation
b. Johns Manville
c. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation

d. Or Approved Equal.

C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.

1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

2. Thermal Resistance: R-value (RSI-value) as shown on Drawings.

3. Manufacturers:

a. ROCKWOOL (ROXUL, Inc); COMFORTBATT: www.rockwool.com/#sle.
b. Or Approved Equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.2 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK

A. Installation of board insulation over low slope roof deck as specified in Section 07 41 13 Metal Roof Panels.

B. Board Installation Over Roof Deck, General:

1. See applicable roofing specification section for specific board installation requirements.

2. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.

3. Fasten insulation to deck in accordance with roofing manufacturer's written instructions and applicable Factory Mutual requirements.

4. Do not apply more insulation than can be covered with roofing on the same day.

3.3 BATT INSTALLATION

A. Install insulation and banded liner in accordance with manufacturer's instructions.

B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. Tape seal tears or cuts in banded liner.

3.4 FIELD QUALITY CONTROL

A. See Section 01 45 00 – Quality Control.

3.5 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

SECTION 07 41 13 - METAL ROOF PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Architectural roofing system of preformed steel panels.
B. Metal soffit panels.
C. Miscellaneous accessories.

1.2 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2017a.

B. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection 2019.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2020.

D. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems 2018.

1.3 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Summary of test results, indicating compliance with specified requirements.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Specimen warranty.

C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.

1. Show work to be field-fabricated or field-assembled.

D. Manufacturer Qualification Statement: Provide documentation showing metal roof panel fabricator is accredited under IAS AC472.

E. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1. Accredited by IAS in accordance with IAS AC472.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.6 WARRANTY

A. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of five years from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Metal Roof Panels:

a. Slim-Lok, manufactured by Taylor Metal Products.
b. Medallion-Lok manufactured by McElroy Metal.
c. Or Approved Equal.

2.2 METAL PANELS

A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.

1. Metal Panels: Factory-formed panels with factory-applied finish.

2. Steel Panels:

    a. Steel Thickness: Minimum 24 gauge (0.024 inch) (0.61 mm).

3. Profile: Standing seam, with minimum 1" seam height; concealed fastener system lapped seam in standing seam profile.

4. Texture: Smooth, with intermediate ribs for added stiffness.

5. Length: Full length of roof slope, without lapped horizontal joints.

6. Width: Maximum panel coverage of 16 inches (406 mm).

B. Metal Soffit Panels:

1. Profile: Style as indicated.

2. Material: Precoated steel sheet, 22 gage, 0.0299 inch (0.76 mm) minimum thickness.

3. Color: To match roof panel.

2.3 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.4 FINISHES

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated aluminum surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); color and gloss Kynar "Sandstone" or approved equal.

2.5 ACCESSORIES

A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.

1. Downspouts: Open face, rectangular profile.

B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.

C. Coverboard: Gypsum coverboard per roofing panel manufacturer.

D. Sealants:

1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.

2. Concealed Sealant: Non-curing butyl sealant or tape sealant.

E. Underlayment: Synthetic non-asphaltic sheet, intended by manufacturer for mechanically fastened roofing underlayment without sealed seams.

1. Self Sealability: Passing nail sealability test specified in ASTM D1970/D1970M.

2. Low Temperature Flexibility: Passing test specified in ASTM D1970/D1970M.

3. Fasteners: As specified by manufacturer and building code qualification report or approval.

4. Manufacturers:

a. System Components Corporation, Inc; ProTex: www.systemcomponents.net/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Broom clean wood sheathing prior to installation of roofing system.

B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.

C. Remove protective film from surface of roof panels immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.

D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.

E. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.

1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.

2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.

B. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

C. Install roofing underlayment system before installing preformed metal roof panels. Secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners. Apply from eaves to ridge in shingle fashion, overlapping horizontal joints a minimum of 2 inches (50 mm) and side and end laps a minimum of 3 inches (75 mm). Offset seams in building paper and seams in roofing felt.

D. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by the panel manufacturer.

3.4 CLEANING

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.5 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION

SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install flashing and sheet metal work, including gutters and downspouts, as indicated on the Drawings and by provisions of this Section.

B. Section includes:

1. Galvanized metal flashings
2. Prefinished galvanized downspout and gutter

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

2. ASTM G90 - Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

1.3 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Samples of flashing design, size, and color for approval
2. Preparation instructions and recommendations
3. Storage and handling requirements and recommendations
4. Installation methods

1.4 DELIVERY, STORAGE, AND HANDLING

A. Per Manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Pre-finished Galvanized Steel Sheet:

1. Steel Sheet: 24-gauge, commercial quality.

2. Finish: Complying with ASTM A653, ASTM G90 for hot-dip galvanizing.

    a. Pre-finished with baked-on polyester coating, not less than 1.0-mil thick.

3. Color: Provide material in color selected by Owner.

B. Galvanized Steel Sheet:

1. Steel Sheet: 24-gauge minimum, commercial quality.

2. Finishing: Galvanized, with minimum of 0.20 percent copper content. Complying with ASTM A653, G90 for hot-dip galvanizing, mill phosphatized, unless otherwise indicated.

C. Miscellaneous Materials and Accessories

1. Solder: Except as otherwise indicated or recommended by Metal Manufacturer, provide 100 percent lead free solder for tinning and soldering galvanized metal joints.

2. Visually Exposed Fasteners: Stainless steel pop rivets with heads finished to match color of pre-finished metal material.

3. Concealed Fasteners: Zinc coated, type as required and recommended by Manufacturer for materials and substrates involved.

4. Mastic Sealant -- Polyisobutylene, non-hardening, non-skinning, non-migrating sealant typical for flashing lap joint applications.

2.2 FABRICATED UNITS

A. General

1. Shop fabricate metal counter flashings, cap and sill flashings, and similar items to comply with profiles and sizes shown, and to comply with standard industry details as shown by SMACNA in the “Architectural Sheet Metal Manual.”

2. Comply with metal producers’ recommendations for tinning, soldering, and cleaning flux from galvanized metal fabrications. Provide stainless steel rivets at exposed fastenings in pre-finished metal fabrications.

3. Form exposed sheet metal work without oil-canning, buckling and tool marks, true to line and level with exposed edges folded back to form hems.

4. Where movable joints are required for proper installation of mastic sealant, in compliance with SMACNA standards.

B. Pipe Jack Sleeve Fastenings

1. Fabricate pipe, roof penetration sleeves from galvanized material fully tinned and soldered at seams. Provide stack sleeve of diameter 1/2-inch greater than penetrating pipe and same height above with 3-inch-high conical base and embedment flange 12-inch greater than diameter of base. Furnish flanges at top of stack sleeve for attachment of counter flashing cap.

2. Fabricate counter flashing cap with interior pipe sleeve and conical cap to fit over pipe and stack sleeve. Size interior sleeve to tightly fit pipe diameter and to into pipe not less than 3 inches. Size conical cap to extend not less than 3 inches below top of stack sleeve with space above to permit not less than 1-inch pipe movement. Rivet counter flashing cap to flanges of stack sleeve.

C. Counter Flashings

1. Fabricate counter flashings from galvanized material to size and profiles shown in 10-foot minimum lengths with continuous 20-gauge galvanized cleat at hemmed lower drip edge.

2. Where top leg of counter flashing is not covered by other applied materials or otherwise supported, provide with integral hemmed sealant dam and anchor to wall substrates with 1/8-inch by 1-1/2-inch galvanized float bar, prepared with fastener holes drilled or punched at 8-inch on center. Coordinate size of holes with anchors to be used. Form sealant dam with 3/4-inch minimum outward-turned hemmed leg.

3. At inside and outside corners, provide double lapped, tinned and fully soldered assemblies, shop assembled prior to installation. Do not solder flashing corners after installation other than to render remedial surface repairs. If joint separation should occur, remove flashings and re-solder as required.

D. Cap Flashings

1. Fabricate lap seamed cap flashings from galvanized material with hemmed drips on both sides and continuous 20-gauge galvanized cleat at front edge.

2. Shop assemble cap end-to wall closure flashings with double lapped, riveted, and mastic sealed construction. Provide vertical legs with sealant dam as required for counter flashings.

E. Wall Flashings

1. Fabricate wall flashings from galvanized material with flat locked, mastic filled vertical seams spaced not greater than 4 feet on-center.

2. Form as required to closely follow substrate profile and interlock with counter and cap flashing assemblies without exposed fasteners. Secure to walls with 20-gauge galvanized cleat concealed by edge hems.

PART 3 EXECUTION

3.1 GENERAL

A. Comply with Manufacturer's instructions and recommendation for handling and installation of flashing and sheet metal work.

B. Coordination:

1. Coordinate Work with other work for the correct sequencing of items which make up the entire membrane or system of weatherproofing and rain drainage.

2. Coordinate Work of this Section with interfacing and adjoining work for proper sequence of each installation.

C. It is required that the flashing and sheet metal work be permanently water-tight, and not deteriorate in excess of Manufacturer's published limitations.

D. Provide flashing and sheet metal work which is fully compatible with interfacing or adjoining work to ensure the best total assembly performance for weather resistance and durability.

3.2 INSTALLATION OF METAL WORK

A. Comply with details and profiles as shown and comply with SMACNA "Architectural Sheet Metal Manual" recommendations for installation of the work.

B. Non-Moving Seams: Provide sealed flat-lock seams, except as otherwise indicated. Comply with metal producers' recommendations for tinning, soldering, and cleaning the joints of soldered work.

C. Provide for thermal expansion of all exposed sheet metal work exceeding 20-foot running length, except as otherwise indicated.

D. Conceal fasteners and expansion provisions wherever possible. Fold back edges on concealed side of exposed edges, to form a hem and stiffen material.

E. Provide flashing reglets as shown or as required to seal work to existing substrates. Seal assembled joint with sealant as indicated.

F. Do not proceed with the installation of flashing and sheet metal work until curb and substrate construction, blocking, and other construction to receive the work is completed.

G. Examine the substrate and the conditions under which flashing, and sheet metal work is to be performed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 CLEANING AND PROTECTION

A. Clean visually exposed metal surfaces and other surfaces indicated to be painted. Remove corrosive substances, including soldering flux, which might cause deterioration of metal surfaces or final finish.

B. Provide surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration at time of acceptance by Owner.

END OF SECTION

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SECTION 07 92 00 - SEALANTS AND CAULKING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install sealing or caulking joints between dissimilar materials for watertight seal.

B. Section includes:

1. Sealants
2. Filler gaskets
3. Primers and bond breakers

1.2 DEFINITIONS

A. Sealants: Where the words “sealants” or “caulking” are used in this text, they shall be considered to be synonymous and shall mean sealant or caulking compounds as specified under Part 2 of this specification.

1.3 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.
B. Product data and materials list of items proposed to be provided under this Section.
C. Sufficient technical data to demonstrate compliance with the specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Type A Sealant

1. Application: General building sealant.

2. Material: One component polyurethane sealant.

a. Vulkem 116, as manufactured by Tremco.
b. Sonolastic NP1, as manufactured by BASF.
c. Or approved equal

B. Type B Sealant

1. Application - General building sealant for wide joints.

2. Materials - Self leveling one component polyurethane.

    a. Vulkem 45, as manufactured by Tremco
    b. Or approved equal

C. Filler Gasket (Backer Rod) Cord Strip

1. Ethafoam, as manufactured by Dow Chemical
2. Sonolastic Closed-cell Backer Rod, as manufactured by Sonneborn
3. Or approved equal

PART 3 EXECUTION

3.1 PREPARATION

A. Surfaces to receive caulking materials shall be thoroughly clean and free of any non-compatible primers or protective coatings, including lacquers, form coatings, clear sealers, etc.

B. Brush out all foreign matter and loose particles.

C. Clean metal surfaces with solvents and wipe dry while the surface is still wet with solvent.

3.2 INSTALLATION

A. Primers and Bond Breakers

1. Apply to surfaces as required; verify with Manufacturer.

2. In general, prime all concrete and Portland cement-based plaster or grout surfaces.

3. Prime wood surfaces where specifically required.

4. Use proper type primers and bond breakers, apply per Sealant Manufacturer's printed instructions.

B. Sealants

1. Provide watertight caulked joints at all building exterior locations where possible water penetration through joint may occur.

2. If caulking systems for such joints are not shown, provide as specifically approved.

C. Gaskets or Fillers

1. Compress all gaskets to tight fit. Where required as backing for caulking system, roll or stretch in gasket sections to depth from sealant face or as shown (in general, to 3/8-inch).

2. Install gun grade material with gun nozzle of similar size as joint width as shown. Tool all beads, after application to assume full firm contact. Strike off excess material.

3. Maintain edge surfaces adjacent to joints clean and free of caulking stain and excess material. Trim joints as required per Manufacturer's printed instructions.

4. Do not apply caulking materials to a "bleeding" type of surface, such as asphaltic or other oil-emitting types. Where such material occurs at caulking joint (roofing, etc.), isolate from caulking with gasket filler.

5. Avoid mixing any water in caulking mixture before and during application. Do not thin material.

3.3 CORRECTIONS AND CLEANUP

A. Remove all damaged, defective, or improperly installed sealant and/or caulking and replace.

B. Clean and remove all sealant and caulking from adjacent surfaces.

C. Upon completion of the work, remove all disused implements, rubbish, and debris, and leave premises neat and clean.

END OF SECTION

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SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings and removable stops.

C. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

E. Provide two material Samples for each color of Kynar Finish.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project Site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to finish of factory finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project Site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project Site in time for installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements:

1. Ceco Door Products; an Assa Abloy Group company.

2. Fleming Door Products Ltd.; an Assa Abloy Group company.
3. Steelcraft; an Ingersoll-Rand company.
4. Approved equal.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 metallic coating.

D. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12 pounds per cubic foot density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. Provide 1-3/4-inch-thick doors of materials and ANSI/SDI-100 grades and models specified below, or as indicated on drawings or schedules:

1. Exterior Doors: Level 3, Model 3 – Seamless (with center rail)

a. Exterior doors shall be minimum 16-gauge galvanized or galvanealed steel with both lock and hinge rail edge of door intermittently welded, filled, and ground smooth the full height of door. Exterior doors shall be insulated with a solid slab of expanded polystyrene or polyurethane foam permanently bonded to the inside of each face skin. The top of all doors shall be closed flush by the addition of a 16-gauge screwed-in top cap and sealed to prevent water infiltration. The bottom channel shall include weepholes.

1) Ceco Door, Inc.
2) Curries, Inc.
3) Steelcraft, Inc.
4) Approved equal.

B. All doors shall be reinforced for hardware as shown below where necessary to preclude the use of thru bolts.

1. Exit Devices: 14-gauge
2. Door Closers: 12-gauge

C. All doors shall be beveled 1/8-inch in 2-inch and shall have top and bottom channels of not less than 16-gauge, flush or inverted, welded to the face sheets. Doors shall have a full height 14-gauge hinge rail reinforcement channel, or individual 10-gauge hinge reinforcements.

D. All doors to conform to ANSI-A250.4 Level "A" criteria and shall be tested to 1,000,000 operating cycles and 23 twist tests. Certification of Level "A" doors is to be submitted with approval drawings by supplier upon request. Do no bid or supply any type or gauge of door not having been tested and passed these criteria.

2.4 STANDARD HOLLOW METAL FRAMES

A. Provide hollow metal frames for doors of types and styles as shown on the drawings and schedules. Conceal fastenings unless otherwise indicated.

1. Exterior Frames: Level 2, 16-gauge, galvanized or galvanealed

2. Security Grade Frames: 14-gauge

   a. Ceco: SU Series
   b. Curries: M Series
   c. Steelcraft: F Series

B. All frames over 36-inch in width shall be 14-gauge.

C. Fabricate frames with mitered and faces only welded corners, re-prime at the welded areas. All welds to be flush with neatly mitered or butted material cuts.

D. All frames shall have minimum 7-gauge hinge reinforcements, 14-gauge lock strike reinforcing, and 12-gauge closer reinforcing.

E. All frames shall have minimum 7-gauge hinge reinforcements with an additional high frequency 12-gauge hinge reinforcement welded to the top hinge, 14-gauge lock strike reinforcing, and 12-gauge closer reinforcing.

F. Provide temporary shipping bars to be removed before setting frames.

G. Except on weather-stripped frames, drill stops to receive three silencers on strike jambs of single frames and two silencers on heads of double frames.

H. Provide minimum 0.0179-inch-thick steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

2.5 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in Manufacturer's plant. To ensure proper assembly at Project Site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Astragals: Provide overlapping astragal on one leaf of pairs of doors where indicated. Extend minimum 3/4-inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Post installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

4. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Specification 08 71 00, Door Hardware.

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.

2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.

3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

G. Stops and Moldings: Provide stops and moldings around steel panel where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2. Provide loose stops and moldings on inside of hollow metal work.

2.6 STEEL FINISHES

A. Prime Finish: Apply Manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by Primer Manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2. Finish Coat:

a. As indicated on plans, Coating Schedule

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumbness: Plus or minus 1/16-inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and Manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

b. Install frames with removable glazing stops located on secure side of opening.

c. Install door silencers in frames before grouting.

d. Remove temporary braces necessary for installation only after frames have been properly set and secured.

e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

f. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.

2. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16-inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: Plus or minus 1/16-inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8-inch plus or minus 1/16-inch.

b. Between Edges of Pairs of Doors: 1/8-inch plus or minus 1/16-inch.

c. Between Bottom of Door and Top of Threshold: Maximum 3/8-inch.

d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4-inch.

D. Steel Panel: Comply with installation requirements in Hollow Metal Manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches on center and not more than 2 inches on center from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to Manufacturer's written instructions.

END OF SECTION

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SECTION 08 30 00 - ACCESS HATCHES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers the materials and installation requirements for factory fabricated access hatches.

1.2 DESIGN CRITERIA

A. The unit shall be single leaf, double leaf, or triple leaf as shown on the drawings. The minimum design load shall be AASHTO H20-44, unless otherwise shown or noted. The manufacturer shall guarantee the unit against defects in materials and workmanship for a period of not less than 10 years.

1.3 SUBMITTALS DURING CONSTRUCTION

A. Manufacturer's Data – Provide manufacturer's standard product literature. Installation recommendations shall be provided.

B. Shop Drawings -- Submit copies of shop drawings with physical dimensions and materials of construction. Include plans, elevations and details of sections and connections. Show finishes being provided for all materials being used. Show anchorage and accessory items.

C. Stamped calculations -- Manufacturer shall provide structural calculations stamped by a registered professional engineer, registered in the state of installation, upon request.

D. Samples: Manufacturer to provide material samples upon request and sized to represent material adequately

E. Warranty -- Vault access door manufacturer shall provide the manufacturer's Warranty

1.4 DELIVERY, HANDLING AND STORAGE

A. All materials shall be delivered in manufacturer's original packaging.

B. Store materials in a dry, protected, well-vented area. The contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

C. Remove protective wrapping immediately after installation.

D. Follow the manufacturer's recommendations for delivery, handling and storage.

1.5 SITE CONDITIONS

A. Verify that other trades with related work are complete before installing vault access door(s).

B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.

C. Observe all appropriate OSHA safety guidelines for this work.

1.6 WARRANTY

Manufacturer's standard warranty: Materials shall be free of defects in material and workmanship for a period of (10) Ten years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 PRODUCTS

2.1 GENERAL

A. Doors shall be hinged as shown on the drawings or per manufacturer recommendations. Hardware shall be type 316 stainless steel. This includes nuts, bolts, springs, spring-assisted operators, and automatic hold-open arm with release lever. The door shall be supplied with removable handles to prevent unauthorized entry. Hinged safety grates shall be provided.

2.2 ACCESS DOOR

A. Furnish and install where indicated on plans vault access door type TSGS(single leaf), type TSGD (double leaf), or type TSGT(triple leaf) as indicated on the drawings and in the size as shown on the drawings. The vault access door shall be pre-assembled from the manufacturer.

B. Performance characteristics:

1. Cover (s): Shall be reinforced to support an AASHTO H20-44 wheel load (16,000 LB wheel load over a 10" x 20" area with 30% impact factor) with a maximum deflection of 1/150th of the span.

2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.

3. Operation of the cover shall not be affected by temperature.

C. Covers: Shall be 1/4" (6.3 mm) aluminum diamond plate reinforced to support AASHTO H20 wheel loads.

D. Frame: Channel frame shall be minimum 1/4” (6.3mm) extruded aluminum with a continuous anchor flange around the entire perimeter of the frame.

E. Hinges: Shall be through bolted to the cover with tamperproof Type 316 stainless steel bolts and locknuts and shall be through bolted to the frame with Type 316 stainless steel bolts and locknuts.

F. Drain Coupling: Provide a 1-1/2” (38mm) drain coupling located in the right front corner of the channel frame.

G. A flush lifting handle shall be provided

H. Lifting mechanisms: Manufacturer shall provide the proper amount of lift assist to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing.

2.3 MATERIALS

A. Structural Aluminum Shapes and Plates -- ASTM B 308, Alloy 6061-T6, Anodic Coating Class I, AA-C22-A41, anodized after fabrication.

2.4 HARDWARE

A. Hinges - Type 316 stainless steel hinges shall be provided and shall pivot so the cover does not protrude into the channel frame.

B. Cover -- shall be equipped with a 316 stainless steel hold open arm, with secondary latch which locks the cover in its full upright and open position. A watertight 316 stainless steel slam lock with threaded plug, removable outside key and fixed inside handle shall be mounted on the underside of the cover.

C. Grip handle – provide vinyl grip handle designed to release cover after closing.

D. Operation mechanism – spring operators for ease of operation and automatic hold open arm with release handle.

2.5 SAFETY GRATE

A. The fall through prevention system shall consist of a grate made of 6061-T6 aluminum and be designed to withstand a minimum pedestrian load of 300 lbs. per square foot.

B. The grate openings shall be 4” x 6” to allow both visual inspection and limited accessibility for maintenance purposes when the grate is closed

C. The grate will pivot on stainless steel hinges with 316 SS hardware A 316 stainless steel hold-open device will automatically engage to hold the grate in its full upright and

locked position. The grate shall operate independent of the cover's reinforcing so that the cover will continue to meet specified load and deflection requirements, even if the grate is damaged or removed

D. In the open position the grate will act as barrier to help prevent anyone from stepping into the hatch opening. An aluminum pull rod will be attached to the grate so the operator is positioned with the grate between him and the hatch's opening whenever he pulls on it to raise the grate. The hatch cover will not be able to shut until the grate is closed--thereby insuring the grate is in position when the next operator opens the hatch cover.

E. The grate shall be powder coated with an OSHA safety orange to increase visual awareness of the safety hazard.

2.6 FINISHES

A. Access Hatch Finishes

1. Aluminum hatch shall be provided with standard mill finish. All aluminum in contact with dissimilar metals and concrete shall be provided with manufacturers standard bituminous coating. An adhesive backed vinyl material, that protects the product during shipping and installation, shall cover the entire top of the door.

B. Hardware Finishes

1. Provide type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold open arms and all brackets, hinges, pins and fasteners.

2.7 ACCESS HATCH MANUFACTURER

A. Acceptable access hatch manufacturer shall be USF Fabrication, Inc, or approved equal.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installation, Contractor shall check design drawings and installation conditions and verify the manufacturer's vault access door details for accuracy to fit the application prior to fabrication. Verify all dimensions of the opening prior to installation. The installer shall comply with the vault access door manufacturer's installation instructions. Installer shall insure that the entire unit is installed level and square to insure proper performance.

B. Coordinate installation of the access hatches with other equipment manufacturer's that need use of the access hatch. Apply field coating of bituminous coating, as needed,

to aluminum surfaces in contact to dissimilar metals and concrete. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

3.2 INSTALLATION

A. Install access hatches in accordance with manufacture's recommendations. Coordinate installation with work of other trades.

B. Securely attach frames to supporting work and verify doors, frames and hardware operate smoothly and correctly and are free from warp, twist and distortion.

3.3 CLEANING

A. Thoroughly clean surfaces of grease, oil and dirt and touch up prime coat as needed.

END OF SECTION

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SECTION 08 71 00 - DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Mechanical Door Hardware for the following:

a. Swinging doors: Contractor / Hardware Door Supplier to provide “Schlage” locksets as scheduled in the Hardware Schedule. Owner shall key all new hardware under this project.

2. Cylinders for all door hardware is specified in this Section.

a. “Schlage” interchangeable (IC) core cylinders for Keying to be provided and installed by the Owinder in Contractor / Hardware Door Supplier furnished locksets as shown in Hardware Schedule.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Submittal Sequence: Submit door hardware schedule concurrent submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

1) Identification number, location, hand, fire rating, size, and material of each door and frame.

2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

4) Fastenings and other pertinent information.

5) Explanation of abbreviations, symbols, and codes contained in schedule.

6) Mounting locations for door hardware.

7) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: All cylinders and keying of cores is by the OWNER. OWNER is to provide “Schlage” interchangeable (IC) cores and install.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

C. Warranty: Special warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.

b. Faulty operation of doors and door hardware.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a. Lock and Passage Sets: Five years from date of “Substantial Completion”.
b. Exit Devices (if any): Two years from date of “Substantial Completion”.
c. Manual Closers: 10 years from date of “Substantial Completion”.

1.8 MAINTENANCE SERVICE

A. Maintenance Instructions: Furnish a maintenance instructions manual for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article and as Scheduled on Drawings to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on solid core wood doors and hollow-metal frames.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. McKinney; an ASSA ABLOY Group company.

2.3 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Rockwood Manufacturing Company; an ASSA ABLOY Group Company.

2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated on door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

E. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Schlage “D Series”; Allegion plc.

2.5 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Von Duprin 98 Series; Allegion plc.

2.6 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Schlage; Allegion plc.

B. Lock Cylinders: full size interchangeable (IC) cores provided and installed by Owner; face finished to match lockset.

2.7 ACCESSORIES FOR PAIRS OF DOORS

A. Astragals: BHMA A156.22. (unless shown as welded to hollow metal door)

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Pemko Manufacturing Company; an ASSA ABLOY Group Company.

2.8 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4, Grade 1: rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. LCN; Allegion plc.

2.9 MECHANICAL STOPS AND HOLDERS

A. Wall and Floor Mounted Stops: BHMA A156.16.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Not required.

2.10 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Pemko Manufacturing Company; an ASSA ABLOY Group Company.

2.11 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Pemko Manufacturing Company; an ASSA ABLOY Group Company.

2.12 FABRICATION

A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through

bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications (if applicable):

   a. Machine Screws: For the following:

      1) Hinges mortised to doors or frames.
      2) Strike plates to frames.
      3) Closers to doors and frames.

   b. Steel Through Bolts: For the following unless door blocking is provided:

      1) Surface hinges to doors.
      2) Closers to doors and frames.
      3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.13 FINISHES

A. Provide finishes complying with BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

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

3.2 PREPARATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated on Drawings and / or to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 9200 "Joint Sealants."

F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

I. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: OWNER may engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately six months after date of “Substantial Completion”, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of “Substantial Completion”.

3.7 DOOR HARDWARE SCHEDULE

Door Hardware **Group No. 1: Door No. 1**

Exit Device (with rim cylinder)

Qty.	Item	Basis-of-Design Product		Finish
3 ea	Hinges	McKinney	TA2714 x 4-1/2 x 4-1/2	626
1 ea	Rim Exit Device	Von Duprin	98E0	626
1 ea	Core	Best	Rim Cylinder – Provide new 1C core to Owner	626
1 ea	Surf. Closure	LCN	4040XP – CUSH Arm with 110 hold open arm	626
1 set	Gasketing	Pemco	303AV by door sizes	626
1 ea	Sweep	Pemco	315CN by door sizes	626
1 ea	Threshold	Pemco	272A by door size (see drawing details)	626

END OF SECTION

SECTION 08 72 00 – ROOF HATCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Roof Hatches

a. Thermally broken Roof hatch, Single-leaf metal lid for ladder access, with insulated cover and curb.

1.2 RELATED REQUIREMENTS – NOT USED

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a watertight installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected Work.

1. Hatch Units: Show types, elevations, thickness of metals, and full-size profiles.

2. Hardware: Show materials, finishes, locations of fasteners, types of fasteners, locations and types of operating hardware, and details of installation.

3. General: Show connections of units and hardware to other Work. Include schedules showing location of each type and size of unit

C. Product Data: Manufacturer’s technical data for each type of hatch assembly, including setting drawings, templates, finish requirements, and details of anchorage devices.

1. Include complete schedule, types, locations, construction details, finishes, latching or locking provisions, and other pertinent data.

1.5 INFORMATIONAL SUBMITTALS

A. Provide manufacturer's standard warranty.

B. Sustainable Design Submittals:

1. Building Product Disclosure Requirements: To encourage the use of building products that are working to minimize their environmental and health impacts, provide the following information when available:

    a. Material Ingredients Documentation demonstrating the chemical inventory of the product

1.6 CLOSEOUT SUBMITTALS

A. Manufacturer's Installation Instructions and Operation & Maintenance: Indicate installation, operation and maintenance requirements and rough-in dimensions.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements:

1. OSHA 29 CFR 1910.23 Guarding floor and wall openings and holes

2. OSHA 29 CDR 1919.29 Fall protection systems and falling object protection-criteria and practices.

3. OSHA 29 CFR 1926.502 Fall protection systems criteria

4. International Building Code (IBC) Section 1013.6 Roof Access

5. International Building Code (IBC) Section 1009.11 Means of Egress, Stairways, Stairway to Roof

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site ready use.
B. Exercise proper care in handling of Work so as not to disrupt finished surfaces.
C. Store materials under cover in a dry and clean location off the ground.

1.9 WARRANTY

A. Provide manufacturer's standard 5-year warranty. Roof hatches shall be free from manufacturing defects in materials and fabrication for a period of 5 years from the date of shipment. Should a product fail to function in normal use within this period, manufacturer shall furnish a replacement or new part.

PART 2 PRODUCT

2.1 ROOF HATCH

A. Thermally Broken Roof Hatches:

1. Type and Size: Thermally broken Roof hatch, Single-leaf metal lid for ladder access, with insulated cover and curb design. Size as indicated on the Drawings.

    a. Loads: Minimum 40-lbf/sq. ft. external live load with a maximum deflection of 1/150 of the span and 20-lbf/sq. ft. internal uplift load.

b. Hatch Material:

1) Cover: 0.0907-inch aluminum cover. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM acoustical rated gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

2) Cover insulation: Foil faced Single layer 3-inch rigid polyisocyanurate insulation covered by 0.0907-inch aluminum liner.

a) Minimum R-Value: 20 (U=0.284 W/m2K)

3) Curb: 0.0907 inch aluminum with a single wall curb, integral metal cap flashing of the same gauge and material as the curb, fully welded at the corners. EZ tab counterflash, 9 inches on center, to be bent inward to hold single ply roofing membrane securely in mounting flange continuous around base of frame. Pre-drilled nailing and bolt mounting holes.

a) Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.

b) Sloping Roofs: Where slope or roof deck exceeds 7:12, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level.

4) Curb insulation: Foil faced Single layer 3 inch continuous rigid polyisocyanurate insulation.

a) Minimum R-Value: 20 (U=0.284 W/m2K)

c. Finish: Mill finish

d. Hardware:

1) Hinge Assembly: Pintle hinge with stainless steel hinge pin.

2) Spring: Gas spring with integrated damper.

3) Hold Open Device: Automatic hold open arm. Zinc-plated steel with red vinyl grip handle cover.

4) Latch: Zinc plated steel spring-type slam latch with inside and outside operating turn handles and padlock hasp provisions.

5) Pull Handle: Interior pull down handle, powder coated safety yellow.

2. Manufacturers:

a. Babcock Davis, ThermalMax (RHT)
b. Or Equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.

B. Verify that deck, curbs, roof membrane, base flashing, and other items affecting Work of this Section are in place and positioned correctly.

C. Verify tolerances and correct improper condition

D. Identify conditions detrimental to providing proper quality and timely completions of work.

E. Do not proceed with installation until detrimental conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's recommendations.

1. For Miami-Dade Hurricane Hatch™, install using the manufacturer’s anchoring options as detailed on shop drawings and installation instructions for wood curbs, steel curbs or concrete curbs.

B. Coordinate installation of components of this Section with installation of roof deck, roof structure, roofing membrane, and base flashing.

C. Coordinate installation of sealant and roofing cement with Work of this Section to ensure water tightness.

D. Securely anchor roof accessories in compliance with manufacturer's instructions.

E. Set units plumb, level, and true to line without warp or rack. Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.

F. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal

3.3 ADJUSTING

A. Adjust movable parts for smooth operation

B. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

3.4 CLEANING

A. Clean exposed surfaces per manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION

SECTION 08 80 00 - GLAZING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Glass for windows.
2. Glazing sealants and accessories.
3. Glazing Schedule

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: Current edition of the International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Coated Insulating glass units.
2. Safety (Tempered) glass.

B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturers of insulating-glass units with sputter-coated, low-E coatings glass testing agency and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For coated glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 degrees Fahrenheit.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 5 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products by the following:

1. PPG Industries, Inc – 1-inch Solarban 67 Glass (2) Clear + Clear.

2. Guardian SunGuard – 1-inch SuperNeutral SN68 Glass (2) Clear + Clear

3. See PERFORMANCE REQUIREMENTS for single glaze exterior and interior door lites for Safety Glazing. Exterior and interior door lites to be ¼-inch Tempered / Safety Glazing Units.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Structural Performance: Glazing shall withstand Basic Wind Speed, Importance Factor of 1.0, Exposure C Category within limits and under conditions indicated as determined according to the current edition of the International Building Code (IBC) and ASTM E 1300.

C. Safety Glazing: Where safety glazing (tempered glass) is indicated, provide glazing that complies with CPSC 16 CFR 1201, Category I &II.

1. Where single glaze is scheduled for lites in exterior and interior doors, use 1/4-inch heat-treated clear safety glass (tempered glass).

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 1/4 inch.

2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite; 1-inch Insulating Units

3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu / sq. ft. x h x deg Fahrenheit.

4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.

5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

1. Minimum Glass Thickness for all Lites: 1/4 inch.

E. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.4 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.

2. Spacer: Aluminum with mill or clear anodic finish.

3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Field-applied sealants shall have a VOC content of not more than 250 g/L.

4. Colors of Exposed Glazing Sealants: As selected by from manufacturer's full range during the submittal process.

B. Glazing Sealant: High-Performance Silicone Sealant, medium-modulus, one-part, neutral-curing silicone glazing sealant for a variety of perimeter caulking and glazing applications complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT, M, G, A and O.

1. Manufacturer: Subject to compliance with requirements, provide products by the following:

a. Tremco – Spectrem 2

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg Fahrenheit, ambient; 180 deg Fahrenheit, material surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep systems.

3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression

gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

A. Glass Type: Low-E-coated, clear 1-inch insulating glass.

1. Basis-of-Design Product: Guardian SunGuard – 1-inch SN68 Glass (2) Clear + Clear.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 1 /4 inch (6 mm).
4. Outdoor Lite: Annealed Heat-strengthened Fully tempered float glass.

5. Interspace Content: Air.
6. Indoor Lite: Annealed Heat-strengthened Fully tempered float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: .29 maximum.
9. Summer Daytime U-Factor: .27 maximum.
10. Shading Co-efficient: .43 percent minimum.
11. Visible Light Transmittance: 19 percent minimum.
12. Solar Heat Gain Coefficient: .38 maximum.
13. Light to Solar Gain: 1.80
14. Safety glazing required at exterior full glass door lites (if any).

END OF SECTION

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SECTION 09 20 10 - GYPSUM WALLBOARD

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the work necessary to furnish and install gypsum drywall and accessories where shown on the Drawings, as specified herein and as needed for a complete and proper installation.

B. Section includes:

1. Gypsum wallboard
2. Metal trim
3. Jointing systems
4. Fastening devices
5. Access doors

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board.
2. ASTM C1396 - Standard Specification for Gypsum Board.

1.3 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.
B. Product Data: Manufacturer's data sheets on each product to be used.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Per Manufacturer's recommendations.

PART 2 PRODUCTS

2.1 GYPSUM WALLBOARD

A. General: Provide gypsum wallboard complying with ASTM C1396, in 48-inch widths and in such lengths as will result in a minimum of joints.

B. Regular wallboard: Provide 5/8-inch thick, except as may be shown otherwise on the Drawings.

C. Fire-retardant wallboard: Provide Type X, 5/8-inch thick.

D. Fire-resistant wallboard: Provide Type C, 5/8-inch thick, except as may be shown otherwise on the Drawings.

E. Foil-backed wallboard -- Provide as shown on the Drawings.

2.2 METAL TRIM

A. Form from zinc-coated steel not lighter than 26-gauge, complying with Fed Spec QQ-S0775, Type I, class D or E.

B. Casing beads

1. Provide channel shapes with an exposed wing and with a concealed wing not less than 7/8-inch wide.

2. The exposed wing may be covered with paper cemented to the metal but shall be suitable for joint treatment.

C. Corner beads

1. Provide angle shapes with wings not less than 7/8-inch wide and perforated for nailing and joint treatment or with combination metal and paper wings bonded for joint treatment.

D. Edge beads for use at perimeter of ceilings

1. Provide angle shapes with wings not less than 3/4-inch wide.
2. Provide concealed wing perforated for nailing and exposed wing edge folded flat.
3. Exposed wing may be factory-finished in white color.

2.3 JOINTING SYSTEM

A. Provide a jointing system, including reinforcing tape and compound, designed as a system to be used together and as recommended for this use by the Manufacturer of the gypsum wallboard approved for use on this Work.

B. Jointing compound may be used for finishing if so recommended by its Manufacturer.

2.4 FASTENING DEVICES

A. For fastening gypsum wallboard in place on metal studs and metal channels, use flat-head screws, shouldered, specially designed for use with power-driven tools, not less than 1-inch long, with self-tapping threads and self-drilling points.

B. For fastening gypsum wallboard in place on wood, use 1-1/4-inch type W bugle-head screws or annular ting type nails complying with ASTM C514 and of the length required by governmental agencies having jurisdiction.

2.5 ACCESS DOORS

A. In partitions and ceilings installed under this Section, provide doors where required for access to mechanical installations, electrical installations, and attic spaces.

B. Types:

1. Unless otherwise required, provide 22-inch by 30-inch metal access doors with concealed hinges to metal frame and with Allen key lock.

2. For piercing fire-rated surfaces, provide access doors having the same fire rating as the surface being pierced.

3. Provide prime-coated steel access doors and frames for finish painting to be performed at the job site under Section 09 90 00, Painting and Coating.

2.6 OTHER MATERIALS

A. Provide other materials not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Owner's Representative.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine the areas and conditions under which work of this Section will be performed.
B. Correct conditions detrimental to timely and proper completion of the Work.
C. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:

1. Install gypsum wallboard in accordance with the Drawings and with the separate boards in moderate contact but not forced into place.

2. At internal and external corners, conceal the cut edges of the boards by the overlapping covered edges of the abutting boards.

3. Stagger the boards so that corners of any four boards will not meet at a common point except in vertical corners.

B. Ceilings:

1. Install gypsum wallboard to ceilings with the long dimension of the wallboard at right angles to the supporting members.

2. Wallboard may be installed with the long dimension parallel to supporting members that are spaced 16-inch on centers when attachment members are provided at end joints.

C. Walls:

1. Install the gypsum wallboard to studs at right angles to the furring or framing members.

2. Make end joints, where required, over framing or furring members.

D. Attaching:

1. Drive the specified screws with clutch-controlled power screwdrivers, spacing the screws 12 inches on centers at ceilings and 16 inches on centers at walls.

2. Where framing members are spaced 24 inches apart on walls, space screws 12 inches on centers.

3. Attach double layers in accordance with the pertinent codes and the Manufacturer's recommendations as approved by the Owner's Representative.

4. Attach to wood as required by governmental agencies having jurisdiction.

E. Access Doors:

1. By careful coordination with the Drawings and with the trades involved, install the specified access doors where required.

2. Anchor firmly into position and align properly to achieve an installation flush with the finished surface.

3.3 JOINT TREATMENT

A. General:

1. Inspect areas to be joint treated, verifying that the gypsum wallboard fits snugly against supporting framework.

2. In areas where joint treatment and compound finishing will be performed, maintain a temperature of not less than 55 degrees Fahrenheit (F) for 24 hours prior to commencing the treatment and until joint and finishing compounds have dried.

3. Apply the joint treatment and finishing compound by machine or hand tool.

4. Provide a minimum drying time of 24 hours between coats with additional drying time in poorly ventilated areas.

B. Embedding Compounds:

1. Apply to gypsum wallboard joints and fastener heads in a thin uniform layer.

2. Spread the compound not less than 3-inch wide at joints, center the reinforcing tape in the joint, and embed the tape in the compound. Then spread a thin layer of compound over the tape.

3. After this treatment has dried, apply a second coat of embedding compound to joints and fastener heads, spreading in a thin uniform coat to not less than 6-inch wide at joints, and feather edged.

4. Sandpaper between coats as required.

5. When thoroughly dry, sandpaper to eliminate ridges and high points.

C. Finishing Compounds:

1. After embedding compound is thoroughly dry and has been completely sanded, apply a coat of finishing compound to joints and fastener heads.

2. Feather the finishing compound to not less than 12-inch wide.

3. When thoroughly dry, sandpaper to obtain a uniformly smooth surface, taking care to not scuff the paper surface of the wallboard.

3.4 CORNER TREATMENT

A. Internal Corners:

1. Treat as specified for joints, except fold the reinforcing tape lengthwise through the middle and fit neatly into the corner.

B. External Corners:

1. Install the specified corner bead, fitting neatly over the corner and securing with the same type fasteners used for installing the wallboard.

2. Space the fasteners approximately 6-inch on centers and drive through the wallboard into the framing or furring member.

3. After the corner bead has been secured into position, thread the corner with joint compound and reinforcing tape as specified for joints, feathering the joint compound out from 8-inch to 10-inch on each side of the corner.

3.5 OTHER METAL TRIM, GENERAL

A. The Drawings do not purport to show all locations and requirements for metal trim.

B. Carefully study the Drawings and the installation and provide all metal trim normally recommended by the Manufacturer of the gypsum wallboard approved for use in this Work.

3.6 CLEANING UP

A. In addition to other requirements for cleaning, use necessary care to prevent scattering gypsum wallboard scraps and dust, and to prevent tracking gypsum and joint finishing compound onto floor surfaces.

B. At completion of each segment of installation in a room or space, promptly pick up and remove from the working area all scrap, debris, and surplus material of this Section.

END OF SECTION

SECTION 09 90 00 - PAINTING AND COATING

PART 1 GENERAL

1.1 THE REQUIREMENT

A. Work under this Section shall include the protective coating of all specified surfaces including all surface preparation, pretreatment, coating application, touch-up of factory coated surfaces, protection of surfaces not to be coated, cleanup, and appurtenant work, all in accordance with the requirements of the Contract Documents.

B. This specification is applicable to coated pipe, steel, concrete, and other surfaces listed in the coating schedule at the end of this section. Reservoir painting, pipe corrosion protection systems, galvanizing, and anodizing are specified elsewhere within the contract documents.

C. The Coating System Schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the drawings are used to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

D. Related Work Specified in Other Sections -- Shop coatings and/or factory finishes on fabricated or manufactured equipment may be specified in other divisions. Some items with factory finishes, or corrosion resistant finishes may be scheduled or directed to be painted by the Owner's Representative to unify a wall finish or color scheme, at the Owner's Representative's discretion.

E. Exclusions -- Do not coat the following surfaces unless specified or directed elsewhere: Stainless steel, aluminum, copper, brass, bronze, and other corrosion-resistant material (except for valve bodies and piping); Electrical switch-gear and motor control centers having factory finish; Fencing; Multiple coated factory finished baked enamel or porcelain products; Concealed areas such as ducts, piping, conduits, and items specified elsewhere for special linings and coatings.

F. Damaged Factory Finish -- If directed by the Owner's Representative, refinish the entire exposed surfaces of equipment chipped, scratched, or otherwise damaged in shipment or installation.

G. All coating coming in contact with potable water shall be NSF approved.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified.

1. "Architectural Specification Manual" by the Painting and Decorating Contractors of America (PDCA), 333 Taylor Avenue North, Seattle, Washington 98109.

2. "Systems and Specifications" - Volume 2 of Steel Structures Painting Council (SSPC).

3. NSF International (NSF) Standard No. 61.

4. NSF International (NSF) Standard No. 600 – Health Effects Evaluation and Criteria for Chemicals in Drinking Water (Effective beginning January 1, 2023)

B. References herein to "NACE" shall mean the published standards of the National Association of Corrosion Engineers, P.O. Box 986, Katy, TX 77450.

C. Pipe Coating Commercial Standards

ANSI/AWWA C105	Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
ANSI/AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
ANSI/AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-inch and Larger - Shop Applied
ANSI/AWWA C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Pipelines.
ANSI/AWWA C210	Liquid Epoxy Coating for Exterior and Interior of Steel Pipe.
ANSI/AWWA C213	Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
ANSI/AWWA C214	Tape Coating systems for the Exterior of Steel Water Pipelines.

D. Federal Specifications

DOD-P-23236A(SH)	Military Specification, Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast.

1.3 CONTRACTOR SUBMITTALS

A. Coating Materials List -- The Contractor shall provide a coating materials list which indicates the Manufacturer and the coating number, keyed to the coating systems herein.

B. Coating Manufacturer's and Applicator Information -- For each coating system to be used the Contractor shall submit, the following listed data.

1. Manufacturer's data sheet for each product used, including statements on the suitability of the material for the intended use.

2. Manufacturer's instructions and recommendations on surface preparation and application.

3. Colors available for each product and each coat.

4. Compatibility of shop and field applied coatings (where applicable).

5. Material safety data sheet (MSDS) for each product used.

6. The Manufacturer’s recommended products and procedures for field coating repairs and field preparation of field cut pipe ends.

7. The name of the proposed coating applicator shop along with certification that the applicator shop is qualified and equipped to apply the coatings systems as specified.

8. Certificate -- Submit Manufacturer's certificate of compliance with the specifications and standards signed by a representative in the Manufacturer's employ.

9. Samples -- Provide painted surface areas at the job for approval of main color selections or submit sample on 12-inch sample of substrate using required finish system at Owner’s Representative’s discretion.

1.4 QUALITY ASSURANCE

A. Painter Qualifications -- The Painting/Coating Contractor must be capable of performing the various items of work as specified. The Painting/Coating Contractor shall furnish a statement covering experience on similar work, a list of machinery, plant, and other equipment available for the proposed work, and a financial statement, including a complete statement of the Painter/Coating Contractor’s financial ability and experience in performing similar painting and coating work. The Painting/Coating Contractor shall have a minimum of 5 years practical experience and a successful history in the application of the specified products to concrete/steel surfaces. Upon request, the Painting/Coating Contractor shall substantiate this requirement by furnishing a list of references, which shall include jobs of similar nature.

B. The Contractor shall give the Owner’s Representative a minimum of 3 days advance notice of the start of any field surface preparation work of coating application work,

and a minimum of 7 days advance notice of the start of any shop surface preparation work.

C. All such work shall be performed only in the presence of the Owner’s Representative unless the Owner’s Representative has granted prior approval to perform such work in its absence.

D. Inspection by the Owner’s Representative, or the waiver of inspection of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.

E. Surface Preparation -- Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces with the standard samples available from the NACE, using NACE standard TM-01-70.

F. Scaffolding shall be erected and moved to locations where requested by the Owner’s Representative to facilitate inspection. Additional illumination shall be provided by the Contractor to cover all areas to be inspected.

G. Paint Products -- No request for substitution shall be approved which decreases the film thickness designated or the number of coats to be applied, or which offers a change from the generic type of coating specified. Painting shall be done at such times as the Contractor and Owner’s Representative may agree upon in order that dust-free and neat work be obtained. All painting shall be in strict accordance with the Manufacturer's instructions and shall be performed in a manner satisfactory to the Owner’s Representative.

H. Manufacturer's Representative -- Require Coating Manufacturer's representative to be at job site when the first day's coating application is in progress and periodically during progress of the work.

I. Labels -- Deliver to the job site in the original sealed containers with Manufacturer's name, product name, type of product, Manufacturer's specification or catalog number or federal specification number, and instructions for reducing where applicable.

J. Colors -- Colors will be selected from Manufacturer's standard colors as reviewed by Owner’s Representative and approved by the Owner. Colors for special coatings that are limited in their availability and color selection will be chosen on the basis of Manufacturer's standard colors, provided that the Manufacturer's product line represents a color range comparable to similar products of other manufacturers.

K. Flame Spread -- Provide paint materials which will result in a Class II finish for all coated surfaces in exit corridors, and a Class III finish for all other interior rooms or areas.

L. Film Thickness Testing -- On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC "Paint Application Specification No. 2" using a

magnetic-type dry film thickness gauge such as Mikrotest model FM, Elcometer model 111/1EZ, or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using wet film gauge readings and destructive film thickness tests.

M. Inspection Device -- The Contractor shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gauges shall be made available for the Owner's Representative use at all times while coating is being done, until final acceptance of such coatings. The Contractor shall provide the services of a trained operator of the holiday detection devices until the final acceptance of such coatings.

N. Holiday Testing -- The Contractor shall holiday test all coated ferrous surfaces. Areas which contain holidays shall be marked and repaired or recoated in accordance with the Coating Manufacturer's printed instructions and then retested.

1. Coatings With Thickness Exceeding 20 Mils -- For surfaces having a total dry film coating thickness exceeding 20 mils: pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Coatings With Thickness of 20 Mils or Less -- For surfaces having a total dry film coating thickness of 20 mils or less: Tinker & Rasor Model M1 nondestructive type holiday detector, K-D Bird Dog, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flo, or equal, shall be added to the water prior to wetting the detector sponge.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver in labeled containers as specified above and store in a locked room accessible for inspection. Comply with fire and health regulations.

B. Provide adequate heat and forced mechanical ventilation for health, safety, and drying requirements. Use explosion proof equipment. Provide face masks.

C. Protect adjacent surfaces with suitable masking and drop cloths as required. Remove cloths or waste from the Project daily.

D. Apply to surfaces under recommended environmental conditions and within the limitations established by the Material Manufacturer. Do not apply coating in snow,

rain, fog, or mist; or when the relative humidity exceeds 85 percent; or to damp or wet surfaces, unless otherwise permitted by the Coating Manufacturer's printed instructions. Coating application may be continued during inclement weather only if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the Paint Manufacturer during application and drying periods.

1.6 PROTECTION

A. Follow all safety recommendations of Manufacturer regarding ventilation and danger from explosion or breathing paint fumes or skin exposure, and all applicable O.S.H.A. and other regulations.

B. Protect surface adjacent to work being coated from overspray, drips or other damage.

1.7 EXTRA STOCK

Provide one gallon of each type and color, fully labeled, at completion of job.

PART 2 PRODUCTS

2.1 GENERAL

A. Definitions -- The terms "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, tape, and all other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The term "DFT" means minimum dry film thickness.

B. General -- Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, Manufacturer's directions, and name of Manufacturer, all of which shall be plainly legible at the time of use.

C. The Contractor shall use coating materials suitable for the intended use and recommended by their Manufacturer for the intended service.

D. Compatibility -- In any coating system only compatible materials from a single manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, subject to the approval of the Owner’s Representative, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

E. Colors -- All colors and shades of colors of all coatings shall be as selected or specified by the Owner’s Representative. Each coat shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected

from the Manufacturer's standard color samples by the Owner’s Representative Color pigments shall be lead free.

F. Protective Coating Materials -- Products shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. Where requested, the Contractor shall provide the Owner’s Representative with the names of not less than 10 successful applications of the proposed Manufacturer's products demonstrating compliance with this specification requirement.

G. Substitute or "Or-Equal" Submittals -- Unless otherwise specified, materials are from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed. The Contractor shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or equal" material that said material meets the specified requirements and is equivalent or better than the listed materials.

H. The cost of all testing and analyzing of the proposed substitute materials that may be required by the Owner’s Representative shall be paid by the Contractor. If the proposed substitution requires changes in the contract work, the Contractor shall bear all such costs involved and the costs of allied trades affected by the substitution.

2.2 INDUSTRIAL COATING SYSTEMS

A. General

Provide and apply the industrial coatings systems which follow as listed in the coating schedule, as required by these specifications, and as directed by the Owner’s Representative. Coat all existing and new exposed interior or exterior surfaces and submerged and intermittently submerged surfaces as indicated, except as specifically excluded in Part 1 of this section or on the drawings or finish schedules. Coating System Numbers listed below shall be used as the Coating System code letter, and shall be used on any coating submittals or correspondence.

B. Industrial coating systems shall be as follows

1. Coating System 100

a. Location -- Exposed, unprimed, non-galvanized, nonsubmerged metal surfaces, both interior and exterior including piping, and structural steel.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply prime coat and topcoat, 4.0-6.0 mils each coat of Tnemec Series 66-2 Hi-Build Epoxoline, or equal. Color as selected by Owner.

2. Coating System 101

    a. Location -- Exposed metal surfaces, shop primed, both interior and exterior including piping, railings, ladders, steel doors, and any other metal items not otherwise specified.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Apply shop prime coat 3.0 mils DFT Tnemec Series 90-97 Tneme-Zinc, one coat 4.0 - 6.0 mils DFT Tnemec Series 66 Hi-Build Epoxoline, and 3.0 - 4.0 mils DFT of Tnemec Series 175 Endura Shield, or equal. Color as selected by Owner.

3. Coating System 102

    a. Location -- Unprimed or non-galvanized, continuously or intermittently submerged metal items, both interior and exterior including piping, structural steel, and all other metal items not otherwise specified.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Prime, intermediate and topcoat, 4.0-6.0 mils each coat of Tnemec Series 20 Pota-Pox, or equal. Color as selected by Owner.

4. Coating System 103

    a. Location -- Vertical concrete walls, exterior, below finish grade, not exposed to view.

    b. Surface Preparation -- As specified herein.

    c. Paint System -- Apply two coats 9.0-10.0 mils each, Carboline Bitumastic 50, or equal.

5. Coating System 104

    a. Location – Non-submerged, exposed to view, PVC piping.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Apply one coat, 4.0-6.0 mils Tnemec Series 66-2 Hi-Build Epoxoline, or equal. Color as selected by Owner.

2.3 SPECIAL PIPE AND SEVERE SERVICE COATING SYSTEMS

A. General

The following coatings are for buried pipe and surfaces used in severe service conditions. The Manufacturers' products listed in this paragraph are materials which satisfy the material descriptions of this paragraph and have a documented successful record for long term submerged or severe service conditions. Proposed substitute products will be considered as indicated within the paragraph entitled " 'Or-Equal' Clause" in Section 01 33 00, Submittal Procedures.

B. Special pipe and severe service coating systems shall be as follows

1. Coating System 200 -- Cement Mortar Coating

   a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

   b. Surface Preparation - As specified herein.

   c. Coating System -- A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than 1-part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane-Forming Compounds for Curing Concrete" ASTM C 309-81, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped by at least 6 inches. At the Owner's Representative's discretion, the hot applied coal tar epoxy coating may be used as the curing membrane for the mortar coating.

2. Coating System 201 -- Hot Applied Coal Tar Epoxy Coating

   a. Location -- Exterior surface of concrete pipe and cement-mortar coated pipe and fittings.

   b. Surface Preparation -- As specified herein.

   c. Coating System -- The hot applied coal tar epoxy shall be a solvent free 100 percent solids coal tar epoxy chemically compatible with hydrating cement and suitable for application on moist surfaces of freshly placed cement mortar or concrete and properly prepared cured surfaces. The coal tar epoxy coating material shall be Amercoat 1972B or equal. The finish coal tar epoxy coating shall have a minimum DFT of 26 mils.

3. Coating System 202 -- Coal-Tar Epoxy Coating System

a. Location -- Exterior surface of buried steel pipe, fittings, and other ferrous surfaces.

b. Surface Preparation -- As specified herein.

c. Coating System -- High build, two-component amine or polyamide cured coal-tar epoxy shall have a solids content of at least 68 percent by volume, suitable as a long term coating of buried surfaces, and conforming to AWWA C210. Prime coats are for use as a shop primer only. Prime coat shall be omitted when both surface preparation and coating are to be performed in the field. The coal-tar epoxy coating system shall include:

1) Prime coat (DFT = 1-1/2 mils), Amercoat 83HS, Tnemec P66, or equal.

2) Finish coats (Two or more, DFT = 18 mils), Amercoat 78 HB, Tnemec 46 H-413, or equal.

3) Total system DFT = 19-1/2 mils.

4. Coating System 203 -- Fusion Bonded Epoxy

a. Location -- Ferrous surfaces of sleeve couplings, steel pipe, and fittings.

b. Surface Preparation -- As specified herein.

c. Coating System -- The coating material shall be a 100 percent powder epoxy applied in accordance with the ANSI/AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines". The coating shall be applied using the fluidized bed process.

1) Liquid Epoxy -- For field repairs, the use of a liquid epoxy will be permitted, applied in not less than three coats to provide a DFT 16 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the Powder Epoxy Manufacturer.

2) Coating (DFT = 16 mils), Scotchkote 203, or equal.

3) Total system DFT = 16 mils.

5. Coating System 204 -- Hot, Coal-Tar Enamel

a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

b. Surface Preparation - As specified herein

c. Coating System -- Coal-Tar Enamel materials and procedures shall be in accordance with ANSI/AWWA C203. This system shall consist of a primer layer,

coal-tar enamel layer, coal-tar saturated non-asbestos felt outer wrap, and a finish coat. Total system DFT = 188 mils.

6. Coating System 205 -- Hot Applied Tape

    a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Tape coating materials and procedures shall be in accordance with ANSI/AWWA C203. This system shall consist of a cold-applied liquid primer and heated coal-tar base tape. Total system DFT = 50 mils.

7. Coating System 206 -- Cold Applied Tape

    a. Location -- Exterior surfaces of buried steel pipe and fittings, non-galvanized.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Tape coating materials and procedures shall be in accordance with ANSI/AWWA C209. Prefabricated tape shall be Type II. The system shall consists of a primer layer, inner layer tape of 35 mils, and an outer layer tape of 35 mils. Total system DFT = 70 mils.

8. Coating System 207 -- PVC Tape

    a. Location -- Small galvanized steel pipe and fittings.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Prior to wrapping pipe with PVC tape, the pipe and fittings shall be primed using a primer recommended by the PVC Tape Manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half lapped for a total thickness of 40 mils.

9. Coating System 208 -- Mastic

    a. Location -- Pipe and fitting joints, and general buried surface coating repair and touch up.

    b. Surface Preparation - As specified herein.

    c. Coating System -- Mastic shall be a one-part solvent drying heavy bodied thixotropic synthetic elastomeric coating with chemically inert resins and fillers and an average viscosity of 650,000 CPS at 77 degrees Fahrenheit (F), thereby requiring generous applications by hand or trowel. Total coat thickness shall be

30 mils, minimum. Mastic shall be Protecto Wrap 160 H or equal and be fully compatible with pipeline coating systems.

10. Coating System 209 -- Polyethylene Encasement

    a. Location -- Ductile iron, steel and concrete cylinder pipe and fittings

    b. Surface Preparation -- None required.

    c. Coating System -- Except as otherwise specified, application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

2.4 ARCHITECTURAL COATING SYSTEMS

A. General

"Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or topcoat.

Fungus Control: Submit evidence for all paints attesting the passing of Federal Test Method Standard No. 141, Method 6271.1 showing no fungus growth or other approved test results.

Apply to surfaces under recommended environmental conditions and within the limitations established by the Material Manufacturer. Acrylics require 60 degrees F and above temperature and below 50 percent relative humidity. Apply water-based paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 50 degrees F and 90 degrees F unless otherwise permitted by the Paint Manufacturer's printed instructions.

B. Architectural coating systems shall be as follows

1. Coating System 300

    a. Location -- Vertical, exterior concrete masonry unit walls exposed to view.

    b. Surface Preparation -- As specified herein.

    c. Coating System -- Apply prime, intermediate and topcoat, 75 square foot per gallon (ft^2/gal), 100 ft^2/gal and 100 ft^2/gal respectively for each coat of Tnemec Series 156 Envirocrete or equal. Color as selected by Owner.

2. Paint System 301

    a. Location -- Vertical concrete exterior walls and flat concrete exterior roofs and slabs exposed to view.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply two coats 6.0-9.0 mils (100 ft^2/gal) each coat, Tnemec Series 156 Envirocrete, or equal. Color as selected by Owner.

3. Paint System 302

a. Location -- Interior concrete masonry unit walls and interior and exterior wood walls, ceilings, and other wood surfaces not otherwise specified, exposed to view.

b. Surface Preparation -- As specified herein.

c. Coating System -- Prime as specified by Coating Manufacturer. Apply two coats 6.0 - 9.0 mils (100 ft^2/gal) each coat, Tnemec Series 156 Envirocrete, or equal. Color as selected by Owner.

4. Paint System 303

a. Location -- Wood surfaces not otherwise specified, exposed to view.

b. Surface Preparation -- As specified herein.

c. Coating System -- Apply an alkyd primer as recommended by the Manufacturer, 2 mils. Apply finish coats (two or more coats 6 mils total) of single component, water based acrylic latex coating, Tnemec Series 6, Carboline 3350 or equal. Total DFT = 8 mils. Color as selected by Owner.

5. Paint System 304

a. Location -- Interior drywall surfaces not otherwise specified, exposed to view.

b. Surface Preparation - As specified herein.

c. Coating System -- Apply two coats 2.0 - 3.0 mils each coat of single component, water based acrylic latex coating, Tnemec Series 6, Carboline 3350 or equal. Color as selected by Owner.

6. Paint System 305

a. Location -- Exterior brick surfaces not otherwise specified, exposed to view.

b. Surface Preparation -- Surfaces shall be cleaned with a Manufacturer's approved chemical cleaner and power washed. Surfaces shall be completely dry, free from efflorescence, oils, paint, and other contaminants before the coating system is applied. Coating system shall be applied according to the Manufacturer's published recommendations. A Manufacturer's representative

shall be present during application of the coating system, if required by the Manufacturer’s warranty.

c. Coating System -- Apply two coats of masonry water retardant material. The system shall be clear, non-staining, silane-modified-siloxane, Fabrishield 161, Rainstopper 1500, or equal. The selected coating system shall provide a minimum of a 5-year Manufacturer’s warranty.

PART 3 EXECUTION

3.1 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations -- Unless otherwise specified herein, the Coating Manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for all other procedures relative to coating shall be strictly observed.

B. All protective coating materials shall be used within the Manufacturer's recommended shelf life.

C. Storage and Mixing -- Coating materials shall be protected from exposure to cold weather, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings of different manufacturers shall not be mixed together.

3.2 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification.

1. Solvent Cleaning (SSPC-SP1) -- Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC-SP2) -- Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC-SP3) -- Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC-SP5) -- Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products, and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC-SP6) -- Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC-SP7) -- Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC-SP10) -- Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. High- and Ultra High- Pressure Water Jetting (SSPC-SP12): Water jetting at high- or ultra-high-pressure to prepare a surface for recoating using pressure above 10,000 pounds per square inch (psi).

9. Surface Preparation of Concrete (SSPC-SP-13) - Surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems.

10. Industrial Blast Cleaning (SSPC-SP14): Blast cleaning to remove all visible oil, grease, dust and dirt, when viewed without magnification

3.3 CORRECTIONS AND CLEANUP

At completion any damaged, de-laminated or defaced coated surfaces shall be touched up, restored, and left in first class condition. Any coated or finished surfaces damaged in fitting or erection shall be restored. If necessary, an entire wall shall be refinished rather than spot finished. Upon completion and prior to final acceptance, all equipment and unused materials accumulated in the coating process shall be removed from the site and any spillage, spatter spots or other misplaced coating material shall be removed in a manner which will not damage surfaces. Perform required patching, repair, and cleaning to the satisfaction of the Owner's Representative. Cooperate and coordinate work with the work of other trades in the removal and replacement of hardware, fixtures, covers, switch plates, etc., as required for coating.

3.4 SURFACE PREPARATION

A. General

Prepare all surfaces scheduled to receive new coating systems, as required to provide for adequate bonding of the specified coating system to the substrate material. Request review of prepared surfaces by the Owner's Representative prior to proceeding. For existing coated surfaces, hand wash with cleaner or product recommended by Coating Manufacturer to properly prepare existing surface and

provide for bonding of coating specified to follow. Remove any loose, peeling or flaking coating, or mildewed areas. Surface preparation minimums shall be as follows:

1. Exposed metal items, non-submerged, unprimed, non-galvanized both interior and exterior, including: piping, structural steel and all other metal items not otherwise specified, shall undergo surface preparation in accordance with SSPC-SP6, "Commercial Blast Cleaning".

2. Exposed metal items, shop primed, both interior and exterior including: piping, steel doors, steel ladders to be painted, and railings, and all other metal items not otherwise specified, shall undergo surface preparation in accordance with SSPC-SP1, "Solvent Cleaning"; SSPC-SP2, "Hand Tool Cleaning"; and SSPC-SP3, "Power Tool Cleaning" as may be required to remove grease, loose, or peeling or chipped paint.

3. Metal items, unprimed or non-galvanized, continuously or intermittently submerged, both interior and exterior including: piping, structural steel, and all other metal items not otherwise specified, shall undergo surface preparation in conformance with SSPC-SP10, "Near-White Blast Cleaning".

4. Stainless Steel – Non-submerged and submerged, exposed piping and fittings, both interior and exterior shall undergo surface preparation in accordance with SSPC-SP1, "Solvent Cleaning".

5. Polyvinyl Chloride (PVC) – Non-submerged, both interior and exterior, process piping and plumbing, shall be lightly sanded prior to application of the specified coating system to follow.

6. Non-submerged Concrete - Clean all concrete surfaces of dust, form oil, curing compounds, or other incompatible matter. Etch and prime if required by Manufacturer for specified coating products to follow. Allow minimum 28-day cure of concrete prior to application of coating systems.

7. Concrete Masonry Units -- Repair all breaks, cracks and holes with concrete grout. The surface must be free of dirt, dust, loose sand and other foreign matter. Brush clean. Allow minimum 28-day cure of concrete joint mortar and repair grout prior to application of coatings system.

8. Wood -- Wood surfaces shall be thoroughly cleaned and free of all foreign matter with cracks, nail holes, and other defects properly filled, smoothed, and sandpapered to fine finish. Wipe clean of dust.

9. Preparation of All Existing Coated Surfaces -- Removed rough and defective coating film from material surfaces to be painted. Touch up with approved primer. Clean all greasy or oily surfaces, to be painted, with benzine or mineral spirits or Rodda's

Gresof before coating, or as recommended by Manufacturer. For walls, patch existing nicks and gouges, sand to match wall finish.

3.5 PRIME COATING

A. Exposed Steel -- Prime coat all exposed steel in accordance with SSPC PS 13.01 for epoxy-polyamide coating systems. Prime coats shall be applied following completion of surface preparation requirements as specified in paragraph 3.4.A.1 above.

B. Galvanized Metal -- After surface preparation specified above, prime galvanized metal items receiving paints as specified with Tnemec Series 66 Hi-Build Epoxaline or equal, verifying with Manufacturer before application the compatibility with coatings specified to follow.

C. Shop Primed Metal -- Where indicated on the plans or coating schedule and following the surface preparation procedures specified in paragraph 3.4.A.2 above, the Contractor shall apply intermediate and topcoats of the specified paint system to shop primed metal. The Contractor shall verify with the Manufacturer(s) representative of the item(s) to be painted, before application, the compatibility of shop primers with the specified intermediate and topcoat coating systems.

D. Non-Shop Primed Metal and Piping -- Prime coat all exposed metal and piping, except stainless steel, received at job site following completion of surface preparation requirements as specified in Paragraph 3.4.A.1 above. Prime paint in accordance with SSPC PS No. 13.01 for epoxy-polyamide primers. Epoxy-polyamide primers shall conform to the standards set forth in SSPC Paint Specification No. 22.

E. Cast-In-Place Reinforced Concrete -- After surface preparation specified above, prime coat concrete as specified in the coating schedule found elsewhere in the specifications.

F. Concrete Masonry Units -- After surface preparation specified above, prime coat as specified in the coating schedule found elsewhere in the specifications.

G. Wood Surfaces -- Following surface preparation specified above, prime coat exterior exposed wood surfaces with appropriate coating system as specified in the painting schedule.

3.6 FIELD PRIME

Wherever shop priming has been damaged in transit or during construction, the damaged area shall be cleaned and touched up with field primer specified herein or returned to the shop for resurfacing and re-priming, at the Owner's Representative's discretion. Metal items delivered to the job site unprimed shall be cleaned and primed as specified herein.

3.7 APPLICATION

A. Thickness -- Apply coatings in strict conformance with the Manufacturer's application instructions. Apply each coat at the rate specified by the Manufacturer to achieve the dry mil thickness specified. If material must be diluted for application by spray gun, build up more coating to achieve the same thickness as undiluted material. Correct apparent deficiency of film thickness by the application of an additional coat.

B. Porous Surfaces -- Apply paint to porous surfaces as required by increasing the number of coats or decreasing the coverage as may be necessary to achieve a durable protective and decorative finish.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.

D. Coatings shall be applied in accordance with the Manufacturer's instructions and recommendations, and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe coating for these areas.

F. Special attention shall be given to materials which will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Ventilation -- Adequately ventilate enclosed rooms and spaces during painting and drying periods.

H. Drying Time -- Do not apply next coat of coat until each coat is dry. Test non-metallic surfaces with moisture meter. The Manufacturer's recommended drying time shall mean an interval under normal condition to be increased to allow for adverse weather or drying conditions. Coating Manufacturer's representative shall verify by cure testing, complete cure of coatings systems used for immersion service.

3.8 COATING SCHEDULE

A. Provided with drawings.

END OF SECTION

SECTION 10 14 10 - IDENTIFYING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary to furnish and install, complete, identifying devices for the Project.

B. Section includes:

1. Process pipe color coding and labeling
2. Process equipment nameplates
3. Door and warning signs

1.2 STANDARDS, SPECIFICATIONS, AND CODES

A. All safety related signs, markers, labeling, and symbols shall conform to the applicable provisions or codes of the Occupational Safety and Health Administration (OSHA), unless specifically modified hereinafter.

B. All signage providing emergency information or general circulation directions, or identifies rooms for the physically handicapped, shall comply with the requirements of the latest edition of American National Standards Institute (ANSI A117.1).

1.3 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Manufacturer's Data - Specifications and installation instructions for each type of sign required.

C. Samples - Submit three full size samples of each color and finish of pipe labeling, process equipment nameplates, and warning signs with sample letters.

1. Owner’s Representative's review of samples will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

2. Submit samples of any other special identifying or signing provided for elsewhere in this specification.

PART 2 PRODUCTS

2.1 PIPE LABELING AND COLORS

A. Unless noted otherwise on the Drawings or specified differently hereinafter, pipe labeling and colors shall conform to the following schedule:

Service	Symbol (label)	Symbol Color (label)	Pipe Color
Plant Water/Potable Water/Well Water	PW	White	Blue
Domestic Water (Cold/Hot)	--	White	Blue
Chlorine Solution	CS	Black	Yellow
Drains	D	White	Gray
Vents	V	Black	Green
Misc. Piping	As directed by the Owner's Representative	As directed by the Owner's Representative	As directed by the Owner's Representative

B. Pipe identification labels and flow direction arrows shall consist of lettering and symbols applied over the pipe base color.

C. Coating systems and surface preparation requirements used in color coding piping and lettering and flow arrows shall be as specified in Section 09 90 00, Painting and Coating.

2.2 PROCESS EQUIPMENT NAMEPLATES

A. Nameplates shall be used to identify all process equipment including but not limited to pumps, chlorinators, control panels, and any other equipment requiring identification as directed by the Owner's Representative.

B. Fabricated from 1/16-inch-thick satin-surfaced Setonply, all edges beveled neatly.

C. Furnish with drilled holes for mounting to the appropriate equipment or nearest adjacent surface. As an alternative, acceptable adhesive attachment methods may be used if approved by the Owner's Representative.

D. Nameplate background color, lettering color, and wording shall be as directed by the Owner's Representative and approved by the Owner.

E. Minimum Size: 4-inch x 1-1/2-inch.

F. Manufacturer: Seton Nameplate Company, New Haven, CT, Style 2060-40 or equal.

PART 3

PART 3 EXECUTION

3.1 PIPE LABELS AND FLOW DIRECTION ARROWS

A. Location: At all connections to equipment, valves, branching fittings, at wall boundaries, and at intervals along the piping not greater than 5 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe. Exposed piping not normally in view, such as behind ceilings and in closets and cabinets, shall also be labeled.

B. Labels shall not be applied to the pipe until all pipe painting is complete or as approved by the Owner’s Representative.

C. Application: By stencil over pipe base color. Base coat shall be cured, clean, and dry, prior to application of lettering.

D. Lettering sizes for pipe labels shall be in accordance with ANSI A13.1, Table 3, and based upon the outside diameter of the pipe to which they are applied.

E. Stripes on solution pipe shall be applied at intervals along the piping not greater than 5 feet on center with at least one stripe applied to each exposed horizontal and vertical run of pipe.

3.2 PROCESS EQUIPMENT NAMEPLATES

A. Location: As directed by the Owner’s Representative.

B. Mounting of process equipment nameplates shall be in accordance with the Manufacturer's instructions, and as directed by the Owner’s Representative.

C. Prepare and mask base material as required to provide clean surface for application of letters by stencil.

D. Unless otherwise noted, color of letters shall be black.

E. Paint Type: Semi-gloss alkyd enamel.

END OF SECTION

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SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section includes requirements to furnish and install, complete, portable fire extinguishers.

B. Section includes:

1. Fire extinguishers

1.2 SUBMITTALS

A. Manufacturer, catalog data for each item including certifications and mounting information.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in Manufacturer's original, unopened protective packaging.

B. Store and handle products in accordance with Manufacturer's instructions to protect them from damage.

PART 2 PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

A. General

1. All Extinguishers:

a. UL listing
b. Charged and ready for service

2. Provide heavy-duty brackets with clip-together strap for wall mounting.

3. Manufacturers: Products of the following, or equal, meeting these Specifications, may be used on this Project:

a. Amerex Corp.
b. Ansul Co.
c. General Fire Extinguishing Corp.
d. J.L. Manufacturing Co.

e. Kiddle Belleville
f. Larsen's Manufacturing Co.
g. Modern Metal Products
h. Potter-Roemer, Inc.
i. W.D. Allen Manufacturing Co.

B. Multi-Purpose Hand Extinguisher (F. Ext-1)

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound (4.5-kilogram) capacity.

PART 3 EXECUTION

3.1 INSTALLATION

A. Portable Fire Extinguishers

1. Provide at locations shown on Drawings.

2. Mount hangers securely in position, in accordance with Manufacturer's recommendations.

3. Top of Extinguisher: No more than 5 feet (1.5 meters) above the floor.

END OF SECTION

SECTION 22 13 16 - SANITARY DRAIN PIPING

PART 1 GENERAL

1.1 SCOPE

This section covers the work necessary to furnish materials, labor equipment and services necessary to provide all sanitary drain piping, equipment and specialties for the plumbing system as shown on the drawings and specified herein.

1.2 QUALITY ASSURANCE

Install plumbing to meet requirements of local and states codes and provide manufacturer's certification that materials meet or exceed minimum requirements as specified.

1.3 SUBMITTALS

Submittals shall include manufacturers certificate of conformance; certified copies of test reports; documentation on plumbing fixtures; fabrication drawings for roof flashing and counterflashing; layout showing type, spacing, maximum loads and materials for hangers and supports and manufacturer's warranty statements.

PART 2 PRODUCTS

2.1 PIPING

A. PVC Pipe:

1. ASTM D 2665 IPS Schedule 40, SOLID WALL piping for drainage/waste andvent (DWV).

    a. Fittings: PVC DWV ASTM D2665.

    b. Joints: Solvent welded, with ASTM D2564 solvent cement, 2-step glue (primer andglue) is required.

B. Cleanouts

1. All cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.

2. Manufacturer's or Equal: The following cleanouts, or equal, shall be furnished:

	Josam	J.R.Smith	Zurn
Exposed locations	58500-20	4405	Z-1440-A
Underground	53010-30	4143	ZN-1400-2
Walls, concealed	58790-20	4535	ZN-1445-1-A
Traffic areas	56070	4240	Z-1420-27

PART 3 EXECUTION

3.1 INSTALLATION

A. All sanitary drain piping shall be installed in accordance with the applicable plumbing code.

3.2 PLUMBING SPECIALTIES INSTALLATION AND APPLICATION

A. The CONTRACTOR shall coordinate the work of roughing-in, wall and floor sleeves, pipe inserts, cutting of roof and floor construction to receive drains and vents to required invert elevations. Pipes below ceilings shall be held as high as possible without interfering with other trades.

B. The CONTRACTOR shall install all plumbing specialties in accordance with manufacturer's printed instructions to permit intended performance.

C. Cleanouts shall be extended to finished floor or wall surface. Threaded cleanout plug shall be lubricated with mixture of graphite and linseed oil. The CONTRACTOR shall ensure sufficient clearance at cleanouts for rodding of drainage system.

D. Exterior cleanouts shall be encased in concrete flush with pavement or they shall be extended to above finished grade in unpaved locations.

END OF SECTION

SECTION 23 38 00 - HEAT PUMP

PART 1 GENERAL

1.1 DESCRIPTION

A. Units shall be factory assembled, single package, designed for outdoor installation. The units shall be factory wired, piped and charged with R-410A refrigerant and factory tested prior to shipment. All unit wiring shall be both numbered and color coded. The cooling performance shall be rated in accordance with DOE and AHRI test procedures. Units shall be CSA certified to UL 1995/CAN/CSA No. 236-M90 standards.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Acoustical Society of America (ASA).
2. Air Movement and Control Association International (AMCA).
3. American Bearing Manufacturers Association (ABMA).
4. ASTM International (ASTM).
5. National Electrical Manufacturers Association (NEMA).
6. Occupational Safety and Health Act (OSHA).
7. Underwriters Laboratories Inc. (UL).

1.3 SUBMITTALS

A. Action Submittals: Provide for all products specified, as follows:

1. Unit tag number or equipment identification as referenced in Contract Documents.
2. Manufacturer’s name and model number.
3. Descriptive specifications, literature and drawings.
4. Dimensions and weights.
5. Capacities and ratings.
6. Construction materials.
7. Manufacturer's standard vibration isolation accessories.
8. Factory finish system.

B. Informational Submittals:

1. Recommended procedures for protection and handling of products prior to installation.

2. Manufacturer’s installation instructions, including seismic anchorage and bracing requirements.

3. Factory test reports.

4. Operation and Maintenance Data.

PART 2 PRODUCTS

2.1 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for Variable Refrigerant Flow (VRF) systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.

E. System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals.

2.2 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendation.

2.3 PERFORMANCE REQUIRMENT

A. Products shall conform to the requirements indicated in the HVAC Equipment Schedule in the Drawings.

B. Pump Room Heat Pump System

1. Cooling 96,000 Btu/hr

2. Heating 108,000 Btu/hr

2.4 MULTI-VRF SYSTEM

A. Outdoor Units

1. General:

    a. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section the Controls section. The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

    b. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.

    c. Outdoor unit shall have a sound rating no higher than 75 dB(A) individually or 78 dB(A) twinned. Units shall have a sound rating no higher than 56 dB(A) individually or 58.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

    d. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.

    e. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.

    f. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.

    g. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

    h. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.

i. The outdoor unit shall be capable of guaranteed operation in cooling mode up to 126 degrees F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as “for reference only” are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.

j. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.

k. The outdoor unit shall be capable of operating in cooling mode down to -22 degrees F with optional manufacturer supplied low ambient kit.

l. Low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.

m. Low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

n. Low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.

o. VRF four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7 gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.

2. Unit Cabinet:

a. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

b. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.

c. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.

3. Fan:

   a. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.

   b. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

   c. All fans shall be provided with a raised guard to prevent contact with moving parts.

4. Refrigerant and Refrigerant Piping

   a. R410A refrigerant shall be required for systems.

   b. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

   c. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.

   d. All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.

   e. Refrigerant line sizing shall be in accordance with manufacturer specifications.

5. Coil:

   a. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.

   b. Outdoor Coil shall be elevated at least 12" from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturers in which

their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12" of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.

c. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.

d. The coil shall be protected with an integral metal guard.

e. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

f. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.

g. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

6. Compressor:

a. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.

b. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.

c. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase

heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.

d. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.

e. The compressor shall be equipped with an internal thermal overload.

f. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

g. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

7. Controls:

a. The unit shall be an integral part of the system & control network and react to heating/cooling demand as communicated from connected indoor e control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.

b. The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

8. Electrical:

a. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.

b. The outdoor unit shall be controlled by integral microprocessors.

c. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

B. Wall Mounted Indoor Units

1. General:

a. The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an

auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

2. Unit Cabinet:

    a. All casings, regardless of model size, shall have the same white finish

    b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.

    c. There shall be a separate back plate which secures the unit firmly to the wall.

3. Fan:

    a. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.

    b. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).

    c. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

4. Filter:

    a. Return air shall be filtered by means of an easily removable, washable filter.

5. Coil:

    a. Basis of design indoor units include factory-installed LEV/EEV. Alternative brands which require field-installed, accessory LEV or EEV kits are permissible only with written Engineer and Architect approval for the location of kits being submitted two weeks prior to bid date. EEV kits mounted in cavities inside fire-rated interior walls shall be mounted inside three hour fire rated enclosures with access panels supplied by the manufacturer. Enclosure type and placement require prior approval.

    b. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.

    c. The coils shall be pressure tested at the factory.

6. Electrical:

    a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

7. Controls:

   a. The unit shall include a programmable thermostat

   b. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

   c. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

   d. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

8. Deluxe Wired MA Remote Controller:

Wired MA Remote Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat. Operation modes vary depending on the air conditioner unit.	Each Group	Each Group
Temperature Setting	Sets the temperature from 40°F – 87°F depending on operation mode and indoor unit.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Vane, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1

Item	Description	Operation	Display
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing a button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group
Schedule	Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point.	Each Group	Each Group

2.5 WARRANTIES

A. Multi-VRF System

1. The MULTI units shall be covered by the manufacturer’s limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.

2. Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the U.S. market.

3. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

4. The MULTI VRF system shall be installed by a contractor with extensive MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

B. Split System

1. The units shall have a manufacturer's parts and defects warranty for a period five (5) years from date of installation. The compressor shall have an extended warranty of seven (7) years from date of installation.

2. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty will not include labor.

3. Manufacturer shall have a minimum of ten (10) years continuous experience in the U.S. market.

4. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required

2.6 MANUFACTURERS AND PRODUCTS:

A. The multi-VRF heat pump system for the facility shall consist of an air handler and heat pump manufactured by one of the following:

1. METUS, models PKFY-P30NKMU-E2.TH and PUHY-HP96YNU-A respectively
2. DAIKIN, models RXYQ96TYDN and FXAQ24PVJU respectively
3. or Approved Equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fans level and plumb.

B. Ceiling Units: Suspend units from structure; use threaded rod or metal straps.

C. Wall Units: Install wall-mounted units from walls using manufacturer's provided wall mounting kits.

D. Labeling: Label fans in accordance with Article Accessories.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

3.2 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.

2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.

3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.

4. Verify that cleaning and adjusting are complete.

5. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.

6. Verify lubrication for bearings and other moving parts.

B. Performance Tests:

1. Starting Procedures:

a. Energize motor and adjust fan to indicated revolutions per minute.
b. Measure and record motor voltage and amperage.

2. Operational Test:

a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.

c. Test and adjust control safeties.

d. Replace damaged and malfunctioning controls and equipment.

3.3 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

END OF SECTION

SECTION 23 83 00 - UNIT HEATERS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Provisions of Division 23 Heating, Ventilation and Air Conditioning apply to this section.

1.2 DESCRIPTION

A. Work in this section includes self-contained heating units such as unit heaters, convectors, finned pipe units, cabinet heaters, and radiant heaters.

1.3 REGULATORY AGENCIES

A. All work shall be in conformance with the requirements of the applicable codes.

1.4 REFERENCE STANDARDS

A. The publications of the organizations listed below form a part of this specification to the extent referenced.

1. National Electrical Manufacturers Association (NEMA)
2. Underwriters Laboratories (UL)

1.5 SUBMITTALS

A. Product Data

1. Electric Unit Heaters

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATERS

A. Manufacturers:

1. Chromalox, HVH
2. Approved Equal

B. Unit heaters shall be electric coil, horizontal blow type with propeller fan, size and capacity as scheduled.

C. Heaters shall be completely factory wired and assembled, with all required electrical power devices and accessories, including automatic re-setting overheat control, wall

bracket, contactors, fuses, transformer, and terminal blocks. Unit shall be UL approved.

D. Heater shall provide the airflow and heating capacity as shown on the Drawings.

E. Heater shall be protected from air flow failure so heater is inoperative unless fan is running.

F. Heater shall be wall or ceiling mounted using the supplier's wall or ceiling mounting hardware.

PART 3 EXECUTION

3.1 INSTALLATION

A. All equipment and accessories shall be installed with required clearances from combustible surfaces. Provide a minimum of 36" clearance in front of the electrical access panel.

B. Wall or ceiling mount unit heaters in accordance with Manufacturer's instructions.

C. When using a non-integral thermostat, install thermostat outside the heater's direct fan exhaust path to avoid on/off cycling.

END OF SECTION

SECTION 26 05 00 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies general requirements applicable to all electrical work to be completed at the facility. This may include such things as underground conduit, surface conduit, motors, control components and similar.

B. Section includes:

1. Scope.
2. Definitions.
3. Reference Standards.
4. Quality Assurance.
5. Submittals.
6. Drawings.
7. Project Site Conditions.
8. Equipment Coordination.
9. Basis of Design.
10. Products.
11. Execution – General.
12. Testing.

1.2 SCOPE

A. This section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other sections but are subject to the general requirements of this section.

B. Related Sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

C. Interfaces to Equipment, Instruments, and Other Components:

1. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to,

but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

2. Provide all material and labor needed to install the actual equipment furnished. Include additional conduit, wiring, terminals, or other electrical hardware to the work, which may be necessary to make a complete functional installation, based on the actual equipment furnished:

    a. Make all changes necessary to meet the manufacturer's wiring requirements.

3. Submit all such changes and additions to the Engineer for acceptance in accordance with the General Conditions.

4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include items that appear on Drawings or in Specifications from another discipline in the scope of Work:

    a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.

D. All electrical equipment and systems for the entire project shall comply with the requirements of Division 26, whether referenced in the individual equipment specifications or not:

1. The requirements of Division 26 apply to all electrical work specified in other Divisions and Sections, including HVAC controls, packaged mechanical systems, Local Control Panels (LCPs), Vendor Control Panels (VCPs), Instruments Junction Boxes (IJBs), Power Junction Boxes (PJBs) and enclosures.

2. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all Subcontractors and suppliers of the Division 26 requirements.

E. Contract Documents:

1. General:

    a. The Drawings and Specifications are complementary and are to be used together to fully describe the Work.

2. Contract Drawings:

    a. The electrical Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the electrical work. Follow the Drawings as closely as possible. Use professional judgment and coordinate with

the other trades to secure the best possible installation. Use the entire Drawing set for construction purposes.

b. Locations of equipment, control devices, instruments, boxes, and panels are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:

1) The equipment locations and dimensions shown on plans and elevations are approximate. Use the Shop Drawings to determine the proper layout, foundation, and pad requirements for final installation. Coordinate with all Subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.

2) The Contractor has the freedom to select any of the named manufacturers, as identified in the individual specification sections. The Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.

c. Installation Details:

1) The Contract Drawings include typical installation details, which show the installation requirements the Contractor is to use to install electrical equipment. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.

F. Utility Coordination:

1. The Contractor shall coordinate with the local electric Utility for the installation of the electrical service at the Owner's facility as specified in section 26 05 85.

1.3 DEFINITIONS

A. WIRING, ELEMENTARY OR SCHEMATIC DIAGRAM: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

B. ONE-LINE DIAGRAM: A one-line diagram shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

C. BLOCK DIAGRAM: A block diagram is a diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

D. CONNECTION DIAGRAM: A connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

E. INTERCONNECTION DIAGRAM:

1. Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams which interface to the interconnection diagrams. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable.

2. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification.

3. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Spare wires and cables shall be shown.

F. ARRANGEMENT, LAYOUT, and/or OUTLINE DRAWINGS: An arrangement, layout, and or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.4 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NECA-1	National Electrical Contractors Association – Standard Practices for Good Workmanship in Electrical Contracting
NFPA-70 NFPA-70E	National Electrical Code (NEC) Electrical Safety in the Workplace
NEMA	National Electrical Manufacturers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IBC	International Building Code
OAR	Oregon Administrative Rules

1.5 QUALITY ASSURANCE

A. IDENTIFICATION OF LISTED PRODUCTS:

1. Electrical equipment and materials shall be listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Factory Mutual (FM), and Electrical Testing Laboratories (ETL). Independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price. Contractor shall comply with Oregon Administrative Code regulations concerning Listing requirements for electrical equipment.

B. FACTORY TESTS: Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall be included in the contract price.

C. DELIVERY AND STORAGE:

1. Delivery and storage per Section 01 66 00.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

   a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

   b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

   c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-

referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

4. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

5. Interconnection diagram: The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified.

6. Conduit layout drawings indicating size, location, and support, for all conduits other than single runs of 1-inch diameter or less cast in concrete construction.

   a. Conduit layout drawings shall illustrate a system which conforms to the requirements of the project.

   b. For changes to the layouts shown on the contract documents, provide engineering design and calculations signed and sealed by a Professional Engineer registered in State of Oregon. Engineering design and calculations shall demonstrate that the proposed layout does not impair or significantly reduce the design structural strength.

7. Safety disconnect switch list including legend with equipment tag, equipment description, and power feeder circuit source and location information.

8. Roof Penetrations: Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

9. Maintenance Data: For all equipment and for components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 77 00 - Project Closeout and 01 78 23 - Operations and Maintenance Data include the following:

   a. Routine maintenance requirements for equipment and components.

10. Manufacturer's written instructions for testing and adjusting.

1.7 WARRANTY

A. Provide a written warranty covering the work done under this Division as required by the General Conditions. Incandescent lamps will be excluded from this warranty.

B. Apparatus:

1. Free of defects of material and workmanship and in accord with the Contract Documents.

2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

3. Operate at full capacity without objectionable noise or vibration.

C. Systems: Any system damage caused by failures of any system component shall be included.

1.8 DRAWINGS

A. Where the Contractor is required to provide information on drawings as part of the specified work, such drawings shall be prepared on 11-inch by 17-inch paper, and on a USB storage Device in AutoCAD 2020. Drawings shall be complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals. Drawings deemed illegible shall be rejected.

B. Where the Contractor is required to provide equipment or system submittal information on drawings as part of the specified work, such drawings shall be prepared on 11-inch by 17-inch paper and shall be included within a three-ring binder. Drawings shall be complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing. Drawing quality and size of presentation shall be such as to permit 50 percent reduction of such drawings for insertion in operation and maintenance manuals. Drawings deemed illegible shall be rejected.

1.9 PROJECT/SITE CONDITIONS

A. GENERAL: Unless otherwise specified, equipment and materials shall be sized and derated for the ambient condition of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. OPERATING FACIILITY: When working in an operating facility, such as a pump station or treatment plant, portions of this facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:

1. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction schedule to meet the requirements of the Owner. All changes in schedule and any needs to reschedule are included in the Work.

2. As weather and operational conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.

3. Coordinate the construction and power renovation, bear all costs, so that all existing facilities can continue operation throughout construction.

C. HAZARDOUS (CLASSIFIED) AREAS: All areas are designated as 'Unclassified' in accordance with the NEC, NFPA 820.

D. SEISMIC: Electrical equipment supports, and anchorage shall be designed and installed in accordance to Section 01 41 20.

1.10 ELECTRICAL NUMBERING SYSTEMS

A. TAGGING: All circuit raceways and armored cables shall be tagged at all terminations, panels, MCCs, pull boxes, junction boxes, etc. in accordance with the assigned numbers on the circuit/raceway schedule and schematic/plan drawings. The tags shall be installed in a clean and high workmanship manner. In addition to tags at the terminations, exposed raceways and armored cables shall be tagged at each side of concealment.

1. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling that apply to the new installation apply equally to the existing installation which forms part of the modified system.

B. PREFIX MODIFIERS: The following prefix modifiers shall be used when scheduling/tagging cables and raceway:

Raceway Prefix	Type of Function
H	Power above 600V
P	Power 120V to 600V
C	Control or power - 120V or less
S	Low level signal (less than 90-volt communication or less than 30-volt instrumentation)
D	Data
PC	Composite of power 120 to 600V and control
F	Optical Fiber
PSP, CSP	Spare power, spare control

C. RACEWAY NUMBERS: Where circuit/raceway numbers have not been assigned, Contractor shall assign raceway numbers in accordance with the system outlined in the drawings.

1.11 CONDUCTOR NUMBERS:

A. WIRE MARKERS: All control and signal conductors in panels, pull boxes, power, instrument, and relay compartments of motor control centers, control cabinets, instrument cabinets, field cabinets and control stations, as well as connections to mechanical equipment, shall be tagged at each end with legible, coded tight-fitting wire-marking sleeve showing the complete wire designation. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8 inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be T&B, SHRINK-KON HVM or equal. Adhesive strips are not acceptable. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

B. INTERNAL WIRING:

1. Wiring within a single enclosure shall be marked with the basic wire and terminal number at each end. The wire number shall designate the terminal or equipment number at each end of the wire separated by a slash.

2. Wiring within MCC buckets shall have a simple numbering scheme, and shall use the same number at each end. (1,2,3,4,5, etc.) Wiring which lands on field terminals shall utilize the terminal number for the internal wire number.

C. FIELD WIRING: All field wiring shall have wire labels at each end. The labels shall be marked with the output terminal number at the original equipment (local control panel or MCC) and the remote device terminal # (if applicable) and tag name separated by a slash. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall be the conductor number specified on the control diagram or if not shown, shall follow the convention below.

1. Wires from MCC buckets shall be labeled with [MCC number (086) - bucket number(A4) - terminal number (6)] (MCC3-A4-6)

2. Wires from Local Control Panels shall be labeled with panel number (PNL2000)-terminal number (12)] (PNL2000-12)

3. Wires from PLC panels or remote I/O panels shall have Rack or Bus (1) – Card or Block (7) -Terminal number(A3) only (1-7-A3)

4. Wires from devices, instruments etc. shall have the instrument or device name and terminal number if applicable. Equipment name is typically DEVICE TYPE - NUMBER. (HS2510) (TSH2510) (FIT2562)

D. EXAMPLE for a control cable from the Area Control Panel PNL2000 bus 1, block 1, terminal A4 to the level transmitter (LIT2501) - the wire tag number at both ends shall be LIT2501 / 1-1-A4. (Do not include the panel name, just the bus, block, terminal number.)

E. EXAMPLE for a control cable from the Area Control Panel PNL2000 rack 4, card 5, terminal A4 to the MCC3, bucket D5 terminal 6 the tag number at both ends shall be MCC3-D5-6/4-5-A4

F. EXAMPLE for a control cable from the MCC3 bucket A4 terminal 12 to device HS4030, the wire tag number at both ends shall be MCC3-A4-12 / HS4030. (Do not include the system abbreviation on devices connected to an MCC bucket.)

1.12 INDICATING LAMP COLORS

A. All indicating lamps shall have an integrated lamp-test function for all lamps on a single line-up of equipment (i.e. Motor Control Center, Switchgear).

B. Unless otherwise specified, indicating lights shall be equipped with colored lenses in accordance with the following schedule:

Color	Function	Example
Green	Run, open valve	Equipment operating, motor running
Red	Stopped, Closed valve	Alarm, end of cycle, motor stopped
White or clear	Normal condition, Ready	Control power on, status OK
Amber (yellow)	Abnormal condition	Failure of equipment or status abnormal, fault condition
Green	Breaker Open	Switchgear breaker illuminated pushbutton
Red	Breaker Closed	Switchgear breaker illuminated pushbutton
Amber (yellow)	Breaker Tripped	Switchgear breaker illuminated pushbutton

1.13 EQUIPMENT COORDINATION

A. The Contractor is responsible to coordinate the equipment supplied from various manufacturers and vendors. This includes but is not limited to:

1. Obtaining specific information on equipment ratings and sizes and verifying the electrical components supplied meet, or match the requirements such as voltage, phase, frequency, starter types, etc.

2. Shall provide equipment that will fit within the space allocated and meet OSHA and NEC clearances.

3. Shall provide coordinated electrical installations with the supplied equipment's electrical power and control requirements.

4. Shall provide power and control equipment, wiring, and raceways to meet the requirements of the mechanical equipment supplied.

5. Shall provide all necessary control wiring and components for any special requirements from an equipment manufacturer.

B. The Contractor shall verify as a minimum:

1. Correct voltage, phase and frequency
2. Size and space requirements
3. Mounting requirements
4. Correct motor starter type and NEMA size
5. Proper coordination with the controls and control System Integrator

C. Any discrepancies between the electrical equipment and other equipment shall be brought to the immediate attention of the Owner.

D. The Contractor shall assure that no instrumentation or control interferences are created by the variable frequency drives (VFDs) or load wiring. The Contractor shall coordinate with the VFD manufacturer to provide necessary separation of conductors or shielding and/or filtering equipment as required by the VFD manufacturer. If interferences do occur, the Contractor shall be responsible to take corrective action at no additional cost to the Owner.

E. WIRING FOR VENDOR PACKAGES:

1. Equipment specifications indicate when the Vendor is responsible for providing interconnection wiring between components of a Vendor package that are installed on separate skids or assemblies. In this circumstance, interconnection wiring between skids or assemblies in a Vendor package is scheduled as "Vendor Wiring" in the conduit/cable schedules.

2. Where equipment specifications do not specify Vendor furnished wiring be- tween skids or assemblies in a Vendor package, the Contractor shall provide and install interconnection wiring between skids or assemblies per the Vendor's interconnection wiring requirements. Interconnection wiring between skids or assemblies in a Vendor package that is furnished and installed by the Contractor is not scheduled in the conduit/cable schedules.

3. Determination of cable requirements.

    a. Coordinate cable/conductor requirements with the selected Vendors to determine the correct wiring required to interconnect the package system components/skids.

    b. Wiring between Vendor furnished components shipped on separate skids or assemblies shall conform to requirements specified in Division 25 and Division 26.

    c. Wiring between the plant control system and Packages system components/skids are specified in the conduit/cable schedules.

    d. Wiring between external power supplies and the packaged system components/skids are specified in the conduit/cable schedules.

4. Assign numbers and tagging for unscheduled raceway, and cable between Vendor furnished components on separate skids or assemblies as specified in Section 26 05 00. Coordinate this information in submittals, record drawings, and O&M manuals provided under this contract.

5. Contract documents shall be updated in the record drawing set to include the work provided for wiring the vendor packages.

1.14 BASIS OF DESIGN

A. The basis of the mechanical and electrical design is the installation of equipment and motors as shown in the electrical one-line drawing(s) and load/panel schedules. In the event that different equipment motors are provided in order for the vendor's equipment to meet mechanical performance requirements, the contractor shall coordinate various suppliers, vendors, and subcontractors to change the required electrical conduit, cables, breakers, motor control center sections, starters units and accessories, etc. as necessary to meet the vendor's equipment installation requirements of the National Electrical Code. The traits and characteristics of all provided materials, equipment, and devices shall meet the specifications. These changes to materials, equipment, and devices shall be at no cost to the Owner. Electrical submittal information shall be coordinated with the equipment and motors provided.

1.15 ARC FLASH MITIGATION METHODS

A. The following mitigation method requirements shall apply to all power distribution and utilization equipment supplied for any products supplied on the project and applies to all equipment divisions in the Contract Documents. Refer to the NFPA-70 (NEC) and NFPA-70E (Electrical Safety in the Workplace) for equipment labeling requirements.

1. EQUIPMENT LABELS: Equipment labels shall be installed on the outside of the electrical equipment enclosure, cabinet, and panels to avoid opening the equipment to access the manufacture's data or the equipment ratings.

2. HINGED DOORS: Power distribution equipment shall have hinged rear doors where back access is shown.

3. REMOTE RACKING DEVICES: Switchboard shall be provided with a remote racking device for Electricians to insert or remove rack- mounted breakers, rack-mounted devices, or auxiliary equipment drawers in- to the associated equipment location.

4. INSULATED POWER BUS AND INSULATED CABLE BOOTS:

    a. Provide insulated power bus in power distribution equipment where accessible to installers or maintenance workers.

    b. Provide cable boots for power conductor connections to insulate the exposed power conductor connections.

5. VIEW WINDOWS FOR MONITORING: Provide protected view windows into cabinets that allow infra-red analyzers, monitors, or cameras to monitor hot temperature for unusual heat generated by deteriorating connections. The view windows shall have a method to move the window protector and hold- in-place during the monitoring operation.

6. POWER AND CONTROL EQUIPMENT SEPARATION:

    a. Provide separation between power equipment within an enclosure, cabinet, or panel by the use of barriers, separate access doors, or by other means.

    b. Provide separation barriers between main breaker feeders coming in- to equipment and other termination points or bussing on the load side of the main breaker.

7. AUTOMATIC SHUTTERS: Provide automatic shutters, where possible, to close the access to the power bus when a power device is not engaged.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. GENERAL: Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. EQUIPMENT FINISH: Unless otherwise specified, electrical equipment shall be painted by the manufacturer as specified in Section 09 90 00.

C. GALVANIZING: Where specified, galvanizing shall be in accordance with Section 05 50 00.

2.2 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 1 AWG or smaller shall have identification sleeves. Conductors No. 2 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

B. Conductors shall be identified in accordance with Section 26 05 00. Adhesive strips are not acceptable.

C. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

D. Conductor and Wire Marker Manufacture:

1. TMS Thermofit Marker System by Raychem Co

2. Sleeve style wire marking system by W. H. Brady Co.

3. Or approved equal

2.3 MC-HL CABLE AND RACEWAY TAGS

A. Tags shall be:

1. Manufactured of permanent metal or heavy mill plastic.

2. Fastened to the raceways at both ends of the tag with permanent fasteners.

a. Fastened to the raceways at both ends of the tag with permanent fasteners.

3. Tag numbers shall be 1-inch tall and machine printed. Hand labeled tags are unacceptable.

2.4 NAMEPLATES

A. Nameplates shall be provided on all electrical devices, including but not limited to motor control equipment, MCC cubicles/cells/buckets, control stations, junction boxes, panels, harmonic filters, instruments, disconnect switches, indicating lights, meters, and all electrical equipment enclosures.

B. Nameplates shall also be provided on all electrical panel interior equipment, including but not limited to relays, circuit breakers, power supplies, terminals, contactors, and other devices.

C. Equipment nameplates shall have both the equipment name and number.

D. Nameplates shall be made of 1/16-inch-thick machine engraved laminated phenolic having black letters not less than 3/16” high on white background or as shown on the drawings or other sections of the specifications. Nameplates on the interior of panels shall be White Polyester with printed thermal transfer lettering and permanent pressure sensitive acrylic; TYTON 822 or approved equal. All nameplates shall include the equipment name and number (and function, if applicable).

E. Provide warning nameplates on all panels and equipment which contain multiple power sources. Lettering shall be white on red background.

F. Nameplates shall be secured to equipment with stainless steel screws/fasteners.

G. Nameplates for disconnect switches shall contain name and number as well as voltage, phases and colors of conductors.

2.5 TERMINAL BLOCKS

A. GENERAL:

1. Terminal Blocks for all contractor supplied equipment and devices shall be manufactured by Allen Bradley, Bussmann, Phoenix Contact, or approved equal.

2. Unless otherwise specified, terminal blocks shall be panhead strap screw type. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the drawings. Terminal blocks for P-circuits (power 120-600 volts) shall be rated not less than the conductor current rating and shall not be rated less than 600 volts AC. Terminal blocks for C-circuits (control and/or control power 120 volts or less) and S-circuits (signal) shall be rated not less than 20 amperes and shall not be rated less than 600

volts AC. Terminals shall be tin-plated. Insulating material shall be nylon. Terminal blocks shall be in accordance with section 26 27 16 for all electrical equipment.

3. Provide terminals for all wire connections to field wiring and internal power distribution. Analog loops that are 24 VDC powered shall have a knife switch to disable the loop if necessary.

4. Connections shall have compression terminals capable of terminating 2 #14 AWG stranded wires. Terminals shall be DIN rail strip mounted as manufactured by Phoenix Contact, or approved equal. Provide number strips for terminal blocks that are referenced by the wire marker. Provide bridge bars for jumpers between terminal blocks. Provide end clamps to separate and terminate terminal block groups. Provide end covers for groups of terminal blocks in sets to match the number points associated with individual I/O cards in the PLC block.

5. Provide Separation Plates on each side of terminals that are at a different potential or polarity than surrounding terminals.

6. Provide clear plastic DIN rail mounted nametag stanchions for each block of terminations. Each nametag shall hold a preprinted label designating the PLC bus and PLC block that terminates to that set of terminals.

7. Terminals shall be mounted such that there is a minimum of 1.5 inches of clear space on both sides of the terminal; for ease of wiring.

8. Mount all terminals strips on 2-inch standoffs.

9. Provide 10 spare terminals or 5% whichever is the greater amount, spare (non-installed) replacement terminals for each type used.

10. Provide wired terminals to match the number of points supplied on each installed I/O card or spare slot in a PLC cabinet.

B. DIGITAL TERMINALS:

1. Terminal Blocks for use in general purpose and digital input terminations shall be Phoenix Contact UK 5, or approved equal. Provide double high terminals for general purpose.

2. Where space is limited for the required number of digital input points double high terminals are permitted if first approved by the Owner.

C. ANALOG TERMINALS:

1. Terminal Blocks for use in analog input terminations shall be knife dis- connect, with socket for analog isolator Phoenix Contact URELG-PMTK, or approved equal.

2. Terminal blocks for analog outputs shall be fused, double high with a separate ground terminal.

3. The wire used for analog inputs and outputs shall be multi-conductor #18 twisted pairs with an overall shield. Provide 4 & 8 pairs to match the in- put or output cards. Wire pairs shall be numbered and colored red for + and black for -. Use BELDEN-M 9520 CMG or approved.

D. FUSED TERMINALS:

1. Fuse terminal blocks shall be hinged disconnect level type with “blown fuse” indicators. PHOENIX CONTACT UK 5 HESI series, or approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. CONSTRUCTION

1. The work under Division 26 shall be performed in accordance with these specifications.

2. Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. The Contractor shall coordinate the field location of electrical material or equipment with the work of other disciplines and subcontractors. Minor changes in location of electrical material or equipment made prior to installation shall be made at no cost to the Owner.

3. The Contractor shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetration, as may be required, shall be based on field conditions. Verify all exact core-drilling locations based on equipment actually furnished as well as exact field placement.

4. The Contractor shall seal all roof penetrations in accordance with approved sealing means.

B. HOUSEKEEPING:

1. Electrical equipment shall be protected from dust, water and damage. Motor control centers, switchgear, and buses shall be wiped free of dust and dirt, kept dry, and shall be vacuumed on the inside within 30 days of acceptance of the work.

2. Before final acceptance, the Contractor shall touch up any scratches on equipment as specified in Section 09 90 00.

3. Electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction shall be adequately protected.

C. ELECTRICAL EQUIPMENT LABELING:

1. Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection.

2. Electrical equipment shall have NFPA 70E labels installed stating the results of the Arc Flash analysis specified in Section 26 05 73.

3. Electrical distribution equipment and utilization equipment shall be provided with field labels to identify the power source and the load as specified. Refer to NEC Article 110.22 for Identification of Disconnecting Means installation criteria. Specific information is required such as the equipment tag number and equipment description of both the power source and the load equipment.

D. MOTOR CONNECTIONS: Verify that the motors are purchased with the correct size motor termination boxes for the circuit content specified in the conduit and cable schedules or submit custom fabrication drawing indicating proposed motor termination box material, size, gasket, termination kit, grounding terminal, boot type insulated motor lead connection (T&B type MSC, or approved equal), and motor terminal box connection/support system. Verify the motor termination box location prior to raceway rough-in.

E. CONDUCTOR INSTALLATION: An enclosure containing disconnecting means, overcurrent devices, or electrical equipment shall not be used as a wireway or raceway for conductors not terminating within the enclosure. Provide wireways, raceways, termination boxes, or junction boxes external to the enclosure for the other conductors.

3.2 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manual. One (1) copy of this document shall be provided with the equipment at the time of shipment.

C. 'Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.3 TESTING

A. GENERAL: Prior to energizing the electrical circuits, insulation resistance measurements tests shall be performed using a 1000-volt megohmmeter to verify the conductor is acceptable for use on the project. The test measurements shall be recorded on the specified forms and provided in accordance with Section 26 08 00 and 26 05 00.

B. INSULATION RESISTANCE MEASUREMENTS:

1. GENERAL:

a. Insulation resistance measurements shall be made on conductors and energized parts of electrical equipment (600V or less). Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

b. Insulation resistance measurements shall be recorded. Insulation with resistance of less than 10 megohms is not acceptable.

2. CONDUCTOR AND CABLE TESTS: The phase-to-ground insulation resistance shall be measured for all circuits rated 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Solid state equipment shall be disconnected, unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

3. MOTOR TESTS: Installed motors shall be tested per Section 26 08 00 shall be completed for each motor after installation. Motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

C. PRE-FUNCTIONAL TEST CHECKOUT: Functional testing shall be performed in accordance with the requirements of Section 26 08 00. Prior to functional testing, all protective devices shall be adjusted and made operative.

1. Submit a description of the proposed functional test procedures prior to the performance of functional checkout.

2. Prior to energization of equipment, perform a functional checkout of the control circuit. Checkout:

a. Energizing each control circuit.

b. Operating each control device, alarm device, or monitoring device.

c. Operate each interlock to verify that the specified action occurs.

D. Verify motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation or momentary energization.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.6 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 77 00 - Project Closeout 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

END OF SECTION

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SECTION 26 05 19 - LOW-VOLTAGE CONDUCTORS, WIRES AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Products.
7. Execution.

1.2 SCOPE

A. This section specifies cables, conductors and fibers including:

1. Stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

2. Copper cables and coax cable rated 300-volt insulation used for data, communication, and signaling.

3. Fiber optic data cable used for data communication.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that

organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-95-658/ NEMA WC70	Non-shielded 0-2kV Cables
NFPA 70	National Electric Code (NEC)
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables
ANSI X3.166	Information Systems--Fiber Data Distributed Interface (FDDI)--Token Ring Physical Layer Medium Dependent (PMD)
EIA RS232D	Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange
EIA RS422	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
EIA RS485	Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
IEEE 802	IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture
IEEE 802.3	Information Processing Systems--Local and Metropolitan Area Networks--Part 3: Carrier Sense Multiple Access with Collision
IEEE 802.3k	Supplement to ISO/IEC 8802-3, Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer
IEEE 802.4	Information Processing Systems--Local Area Networks--Part 4: Token-Passing Bus Access Method and Physical Layer
ANSI/NFPA 72	Installation, Maintenance, and Use of Protective Signaling Systems
ANSI/NFPA 72H	Testing Procedures for Signaling Systems

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from the date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 DEFINITIONS

A. LOW LEVEL ANALOG: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.

B. DATA OR DIGITAL CODE: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized, such as EIA RS422.

C. PULSE FREQUENCY: Counting pulses such as those emitted from speed transmitters.

D. HIGH LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.

E. MODULATED SIGNALS: Signals emanating from modems or low-level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.

F. DISCRETE EVENTS: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.

G. LOW VOLTAGE CONTROL: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

H. HIGH LEVEL AUDIO SIGNALS: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.

I. RADIO FREQUENCY SIGNALS: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood

that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

    d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

4. Catalog cuts showing information of the conductors and cables to be supplied under this section.

5. Field test reports showing conductor and cable insulation resistance test results.

6. Provide engineering pull calculations for all 600V main feeders run underground outside building footprints.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved manufacturers are listed in the Cable Specification Sheets located at the end of this specification section.

2.2 GENERAL

A. UNSCHEDULED CONDUCTORS AND CABLES:

1. With the exception of lighting and receptacle circuits, the type, size and number of conductors shall be as specified on the drawings or schedules. 120V panel circuit conductors mentioned above that are unscheduled and shall be sized by the Contractor in accordance with the breakers specified and the NEC to limit voltage drop to 3 percent. Minimum size of power, lighting, and receptacle circuits shall be 12 AWG. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided. Power, lighting, and receptacle circuit conductors shall be provided in accordance with CABLESPEC "XHHW," unless otherwise specified.

2. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein. Unscheduled conductors shall be sized by the Contractor in accordance with NEC tables and to limit voltage drop to 3 percent.

3. Unscheduled conductors with insulation shall be provided in accordance with the CABLE SPECIFICATIONS in TABLE 2 according to the purpose.

B. CABLE SPECIFICATION SHEETS (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets.

2.3 COLOR CODING

A. POWER AND CONTROL CABLES:

1. Wire coloring shall conform to the color code shown in the table below.

2. Insulation on phase conductors run in conduits sizes #10 AWG and smaller shall be colored, #8 AWG and larger may have black insulation with plastic tape of the appropriate color from the table below.

3. Insulation on the grounded conductor (neutral) sizes #8 AWG and smaller shall be colored, #6 AWG and larger may have black insulation with plastic tape of white or gray in accordance with the table below.

Description	120/208V	277/480V	Control
Phase A (Left)	Black	Brown	--
Phase B (Center)	Red	Orange	--
Phase C (Right)	Blue	Yellow	--
Neutral	White	Gray	White
Ground	Green	Green	Green
120 VAC Control	--	--	Red
120 VAC Control Neutral	--	--	White
DC Control (+)	--	--	Blue
DC Control (-)	--	--	Gray
Signal (+)	--	--	Red
External Source	--	--	Yellow
Computer/Signal Ground			Green/yellow stripe

4. All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block upon entering the enclosure. The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

5. All wiring in industrial machines and equipment shall be in accordance with NFPA 79. Notify owner of any deficiencies noted during installation.

6. Multi-conductor power cable colors shall be manufacturer's standard.

7. Cables sized No. 6 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end. The cables shall be tagged at terminations and in pull boxes, hand holes and manholes.

B. SIGNAL AND DATA CABLES: Unless otherwise specified, cables shall be color coded black and white for pairs or black, red, and white for triads.

2.4 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. SINGLE CONDUCTOR: Single conductor cable shall be stranded copper and shall be used in conduits for power and control circuits. Single conductor cable shall be provided in accordance with CABLESPEC “XHHW” type of conductors unless otherwise specified.

B. MULTI-CONDUCTOR CABLE: Provide multi-conductor power cable and multi-conductor control cable where identified on the drawings. Multi-conductor cables shall be in accordance with CABLESPEC “TC” type cables.

2.5 SIGNAL, DATA AND INSTRUMENTATION CABLES

A. GENERAL:

1. Signal cable shall be provided for instrument signal transmission, alarm, communication, and other circuits as specified. Circuit shielding shall be provided in addition to cable shielding.

2. Single circuit signal cable shall be provided in accordance with CABLESPEC “INS,” unless otherwise specified for hazardous locations type “SP-OS” (ITC/PLTC). Multi-circuit signal cable shall be provided in accordance with CABLESPEC “INS/M,” unless otherwise specified for hazardous locations type “SP-OS” (ITC/PLTC).

3. Terminal blocks shall be provided at cable junction for running signal leads and shield drain wires. Each conductor shall be identified at such junctions.

   a. Shields shall not be used as a ground path.

   b. Shields shall be grounded at one end only. Refer to I drawings for grounding location.

   c. Signal, data, and communication cables shall be terminated and spliced on terminal strips properly mounted and labeled in accordance with this Section and Section 26 05 00. No exceptions.

4. CABLE SPECIFICATION SHEETS (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in Section 26 05 19-3.7.

B. FIBER OPTIC CABLE: Fiber optic cable shall be Multi Mode as shown on the drawings and as specified in the CABLESPEC descriptions.

C. COMMUNICATION, PAGING, AND SECURITY SYSTEM CABLES: Voice communication, paging, and security system cables shall be specified in their respective specification sections.

2.6 WIRE MARKERS

A. 600 VOLT AND 300 VOLT RATED CONDUCTORS:

1. Per 26 05 00 Paragraph 2.2.

B. FIBER OPTIC:

1. Provide Markers for labeling each end of a fiber optic cable. Fiber optic markers must have space for typed or machine printed text.

2. Provide Markers for Individual fiber optic strands, jumpers, and patch cables. Fiber optic markers must have space for typed or machine printed text. Fiber optic markers shall be attached to the fiber using tie wrap or other approved method of securing the marker Listed.

2.7 SPLICING AND TERMINATING MATERIALS

A. 600-VOLT AND 300-VOLT RATED CONDUCTORS:

1. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Connectors for wire sizes No. 10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-spade terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable.

2. In-line splices and taps shall not be used. All circuits shall be continuous though all junction boxes, wireways, pull boxes, etc. until the circuit conductors are terminated at suitable terminal strips within motor control centers, PLC cabinets and panels, distribution panels, local control stations, etc.

3. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated with Thomas and Betts (T&B), MSC series Motor Stub Splice Insulators and sealed with the appropriate tape for the motor voltage. (Example 480V = Scotch 33)

2.8 CORD GRIPS

A. Cord grips shall be provided where specified on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless-steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

2.9 VFD WIRING

A. Shielded power cables (TYPE VFD2/3) shall be used for load-side wire between the VFDs and the motors.

PART 3 EXECUTION

3.1 GENERAL

A. Conductors shall be identified at each connection terminal and at splice points. The identification marking system shall comply with Section 26 05 00.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.2 600-VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing is not necessary in plastic panel wiring duct or wall mounted steel raceway used above countertops. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, hand holes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on unistrut in manholes and hand holes.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power and control conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Splices and terminations are subject to inspection by the Owner prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. In-line splices and tees, where approved by the Owner, shall be made with tubular compression connectors and insulated as specified for motor terminations. Splices and tees in underground hand holes or pull boxes shall be insulated using Scotch-cast epoxy resin or Raychem splicing kits.

6. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating forked compression connectors and terminal strips within a termination/junction box.

7. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (INS or INS/M) then installed in flexible conduit to the actuator control and signal termination compartments.

8. Solid wire shall not be used.

9. Sharing neutrals for power circuits is unacceptable.

10. Conductor and cable markers shall be provided at splice points.

3.3 SIGNAL CABLE

A. Circuits shall be run as individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise

specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Shields shall not be used as a signal conductor.

C. Common ground return conductors for two or more circuits are not acceptable.

D. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Cable for communication systems shall be installed and terminated in compliance with the equipment manufacturer's recommendations and applicable NEC requirements.

F. Cable for data circuits operating at greater than 10 kHz shall be run continuously from node to node without splices or intermediate terminal blocks unless otherwise specifically specified or shown.

G. Cable for low-level instrumentation circuits shall be run continuously between final terminations without splices or intermediate terminal blocks unless otherwise specifically shown or specified.

H. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run.

I. Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.

3.4 INSTALLATION

A. Raceway fill shall be as scheduled, and shall not exceed NEC limitations.

B. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:

1. Where specifically indicated on the drawings.

2. Where field conditions dictate and written permission is obtained from the Owner.

3. Control circuits shall be isolated from the feeder and branch power and instrumentation circuits but combining of control circuits with power is permitted as noted below.

a. The combinations shall comply with the following:

1) 12 VDC, 24 VDC and 48 VDC may be combined.

2) 125 VDC shall be isolated from all other AC and DC circuits.

3) All AC circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.

a. The combinations shall comply to the following:

1) Analog signal circuits may be combined.

2) Digital circuits may be combined but isolated from analog signal circuits.

5. Multiple branch circuits for lighting, receptacle and other 120 VAC circuits are allowed to be combined into a common raceway.

a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NEC, including but not limited to:

1) Up sizing conductor size for required Ampacity de-ratings for the number of current-carrying conductors in the raceway.

2) The neutral conductors may not be shared.

3) Up sizing raceway size for the size and quantity of conductors.

C. Pulling wire and cable into conduit or cable trays shall be completed without damaging or putting undue stress on the cable insulation. Only UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.

D. Whenever a cable leaves a raceway, a cable support shall be provided. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

E. Slack shall be provided in junction and pull boxes, hand holes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required. Plastic panel wiring duct shall not be used in manholes and hand holes.

F. Do not exceed cable manufacturer's maximum recommended pulling tension. Use dynamometer or break-away swivel on pulls exceeding 150 feet.

G. Observe manufacturer's minimum recommended pulling and training radii.

H. Where data cables are installed in cable trays, provide barriers in the tray to separate data cables from power and/or control cables.

I. At each end of the run leave sufficient cable for termination. Coil sufficient cable in each manhole, handhold, or pull box to permit future splice.

J. In-line splices and tees are not allowed.

K. Splices shall not be permitted in any coaxial, twin-axial, or data cable runs.

L. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the panel end.

M. Protect all cables against moisture during and after installation.

N. Install and ground token passing bus cable in accordance with IEEE 802.4. Attach trunk cable to walls and ceilings with PVC clamps with clamp backs at 4- foot intervals.

O. Install and ground Ethernet cable in accordance with IEEE 802.3. Attach trunk cable to walls and ceilings with PVC clamps with clamp backs at 4-foot intervals.

P. Signal and control cable suspended into the wet well shall be provided with heavy duty wire mesh cord grip of flexible stainless-steel wire to take the tension from the cable termination. Strain relief system shall be suitably anchored.

Q. Circuits provided under this Section shall not be direct buried.

3.5 TERMINATIONS

A. Terminations shall be on terminators as identified in Section 26 05 00.

B. Each conductor shall be identified with a wire marker at each terminal to which it is connected. The marking system shall comply with Section 26 05 00.

C. Stranded conductors shall be terminated as described in Section 26 05 19, except where terminals will not accept such terminations. Compression lugs and connectors

shall be installed using manufacturer's recommended tools. Where terminal blocks will not accept lugged conductors, the conductors shall be tinned using 60 percent tin, 40 percent lead alloy non-corrosive resin core solder before insertion into pressure terminals.

D. Electrical spring connectors (wire nuts) shall not be used for any purpose on any cable specified under this Section except for receptacle and lighting circuits. Lugs and connectors shall be installed with a compression tool.

E. All splices and terminations are subject to inspection by the Owner prior to and after insulating.

F. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating forked compression connectors and terminal strips within a termination/junction box.

G. Provide tool-crimp N connectors at coaxial cable terminations except trunk runs.

H. Provide tool-crimp TRN connectors at twin-axial cable terminations.

I. Conductor and cable markers shall be provided at splice points.

J. Fiber Optic Connectors: Active and spare fiber optic cables fibers shall be provided with a breakout kit, and terminated with ST type terminations. ST connectors shall feature:

1. Bayonet Style latch

2. Keyed insertion

3. Spring loading for positive contact

3.6 TESTING

A. GENERAL:

1. The Contractor shall test conductors and cable in accordance with Section 26 08 00. Instrument and Data Cables shall be subjected to additional tests as specified in this section.

B. INSTRUMENT CABLE:

1. Each signal pair or triad shall be tested for electrical continuity. Any pair or triad exhibiting a loop resistance of less than or equal to 50 ohms shall be deemed satisfactory without further test. For pairs with greater than 50-ohm loop resistance, the Contractor shall calculate the expected loop resistance considering

loop length and intrinsic safety barriers if present. Loop resistance shall not exceed the calculated value by more than 5 percent.

2. Each shield drain conductor shall be tested for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.

3. Each conductor (signal and shield drain) shall be tested for insulation resistance with all other conductors in the cable grounded.

4. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt megohmmeter shall be used for insulation resistance measurements.

C. FIBER OPTIC DATA CABLE:

1. Test all data cables, including fiber-optic, with time-domain reflectometer prior to installation.

2. Test all data cables, including fiber-optic, with time-domain reflectometer and transmission impairment analyzer after installation.

3. Test fiber-optic system PMD to FDDI requirements for the following:

4. Transmit power levels

5. AC extinction ratio

6. Optical wave shape

7. Duty cycle distortion

8. Data dependent jitter

9. Random jitter

10. Transmit frequency

11. Minimum optical input

12. Receiver jitter tolerance

D. FIBER OPTIC TESTING: The Owner shall be notified a minimum of 5 days prior to tests and reserve the right to witness field tests.

E. TEST EQUIPMENT:

1. Test equipment shall be traceable to NIST standards. Use the following to perform the pre-installation and post-installation cable tests:

2. Optical time domain reflectometer (OTDR) shall be laser precision, ALT, Inc. Model 5200 LRFL or approved equal.

F. PRE-INSTALLATION TESTS:

1. Perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes. Perform tests on all reels of cable. Cable shall not be installed until the Owner has reviewed the test report.

2. Verify continuity and attenuation or loss for each fiber on each reel and document results of physical inspections to identify any cable and reel damage conditions, and any deviations from the manufacturer’s specifications.

3. Notify the Owner 5 days prior to tests. Document test results and submit the report to the Owner for review. Documentation shall consist of both hard copy and electronic disk complete with application software.

G. POST-INSTALLATION TESTS:

1. OTDR: Conduct the following tests on each cable segment with an OTDR each optical fiber in the fiber cable. Tests shall be conducted at both 1310 and 1550 nm. No splice loss shall have a loss of 0.15 dB or greater with fiber attenuation measured in dB/km.

2. Excess Fiber Coefficient (EFC) Test shall be made as part of the cable testing. The following procedure shall be performed from both ends on each fiber provided.

    a. Prior to stripping the cable for splicing, record the meter marks to determine the physical cable length.

    b. Record the fiber Index of Refraction (IOR) from the cable data submitted by the Manufacturer.

    c. With the OTDR, set to the proper IOR and record the OTDR fiber length.

    d. Calculate the excess fiber coefficient (EFC) according to the following formula: EFC = OTDR length/Sheath length.

H. OLTS FIBER ATTENUATION:

1. Measure the attenuation of each optical fiber in both directions using an Optical Loss Test Set (OLTS) at both 1310 nm and 1550 nm. Test shall be conducted per TIA/EIA 526-7. Provide a reference power level measured with a patch cord and connectors of the same types used on the fiber cable. Measure and record the reference power level of the Laser Light Source. Measure and record the received power level of each optical. Repeat the same measurements in the other direction.

2. The measured insertion loss shall be no greater than the loss calculated in the formula below:

$$IL = 2(Ls) + 2(Lc) + (La)(Length) + 0.5$$

where:

IL		Insertion Loss
Ls	=	Splice losses at the pigtails (maximum 0.15 dB)
Lc	=	Connector face loss (maximum 0.6 dB)
La	=	Manufacturer's cable attenuation (dB/km)
Length	=	Fiber length (km)

I. CABLE ACCEPTANCE:

1. Pigtail splices shall have a loss no greater than 0.15 dB, as determined by either a Profile Alignment System (PAS) or Light Injection (LID) splice loss estimate, at the time the splice is made. Splices with an optical loss of greater than 0.15 dB shall be redone.

2. OTDR traces at both 1310 nm and 1550 nm wavelengths display no unexplained losses, reflectance events, or other discontinuities.

3. The insertion losses measured at both 1310 nm and 1550 nm wavelengths and in both directions do not exceed the maximum allowed values. After cable tests, the cable installation shall be subject to a physical inspection to verify the remaining fiber optic specification requirements have been met. If any test requirements are not met, or in the event of fiber test failure of one or more fibers, splice or replace cable as necessary until tests pass.

J. FIBER OPTIC SYSTEM ACCEPTANCE:

1. Perform the inspection and establish a punch-list of the following:

   a. Fiber splices: neatly organized.

   b. Connectors: capped and undamaged.

c. Cabling: organized with no excessive bending.

d. Specified coiled cable present in the splice cabinet.

e. Cable entrances to the cabinets secured.

f. Unused cable delivered to the Owner.

2. Identify cables with the directories installed in each fiber cabinet. Discrepancies found during the inspection of the fiber system installation shall be listed and provided on the punch-list. Inform the Owner upon resolution and completion of the punch-list items

3.7 CABLE SPECIFICATIONS SHEETS (CABLESPEC)

A. GENERAL: Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.

B. CABLESPEC SHEETS: The following CABLESPEC sheets are included in this section:

CABLESPEC	Volts	Product	Purpose
TC	600	Multi-conductor armored power and control cable	Power and control conductors for use in cable trays and hazardous areas.
XHHW	600	Single conductor cross- linked polyethylene power and control cable	Power and control conductors for use in conduit raceways.
VFD2	600	Shielded motor cable for VFD drives	Feeding motors fed from VFD drive for use in Conduit raceways and Cable Tray.
VFD3	600	Shielded motor cable for VFD drives for large HP motors	Feeding motors fed from VFD drive for use in Conduit raceways and Cable Tray.
CORD	600	Rubber Jacketed multi-conductor cable.	Temporary power cable.
INS	600	Single Pair/Triad #18 ST plus overall shield,	Instrumentation
INS/M	600	Multiple Pair/Triad #18STP plus overall shield,	Instrumentation
NC2	300	Category 6 Ethernet cable, 4 pairs, non-armored	Gigabit Ethernet cable
NC3	300	Category 6 Ethernet cable, 4 pairs, Shielded	Gigabit Ethernet cable
FOT-MM	--	Fiber optic cable – multi- mode	Data Network

IT	300	350 MHz Enhanced Cat 6	Gigabit Ethernet, LAN cable.

CABLE SPECIFICATION SHEETS (CABLESPECs) begin on next sheet:

Cable System Identification: TC

Description:	Multiconductor Power Cable and Multiconductor Control Cable:14 AWG and larger stranded conductors; Cable tray rated.
Power Cable:	Insulated green grounding conductor sized per the NEC.
Ground Conductor Size:	Multiple sets of multiconductor power cable: Oversize the grounding conductor per NEC 250.
Control Cable Type:	ICEA Method 1, E-2, without white neutral conductor or green ground conductor
Control Cable Identification:	Conductors color coded per ICEA and conductors numbered
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8, coated per ASTM B33
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with NEMA WC7, UL 44 and ICEA S-66-524.
Jacket:	Cross-linked Polyethylene (XLP)
Flame Resistance:	IEEE 383
Manufacturer(s):	Okonite, Southwire, General Cable, or approved equal.
Execution:	
Installation:	Install in accordance with this Section.
Testing:	Test in accordance with accordance with this Section and Sections 26 05 00 and 26 08 00.

Cable System Identification: XHHW

Description:	Single conductor Cross-linked polyethylene power and control cable for sizes No. 14 AWG and larger.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with ICEA S-95-658/NEMA WC70.
Jacket:	None.
Manufacturer(s):	Okonite, X-Olene; Durasheath XLP; or approved equal
Uses Permitted:	Power, control, lighting, receptacle and appliance circuits
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00.

Cable System Identification: VFD2

Description:	Shielded motor cable for VFD drives.
Voltage:	600V
Conductor Material:	Finely stranded tinned copper Class 5 stranded: 16-8 awg, and Class K stranded: 2, 4 & 6 awg. Provide pilot or control conductors integral to VFD cable as described in the circuit schedule, shown on the drawings or as required for individual applications.
Insulation:	90 degree C dry or wet, cross-linked polyethylene XPLE in accordance with NEMA.
Assembly:	Individual conductors cabled together with barrier tape, 100% shielding with foil tape and tinned copper braid (85% coverage) inside specially formulated thermoplastic elastomer (TPE) black jacket.
Jacket:	TPE black jacket UL listed to -25 deg C, UL TC-ER listed

Minimum bend radius of 7.5x overall cable diameter.

Flame	IEEE 383
Resistance:	
Manufacturer(s):	Olflex VFD 2XL Beldon 295XX SAB Cables – VFD Combo XLPE (includes up to 2 pr of control conductors) or approved equal.
Uses Permitted:	Cable tray, conduit, exposed in normal or Class 1, Div 2 per NEC 336, 392 and 501 environments
Execution:	
Installation:	Install in accordance with this Section. Provide cable seals where required by NEC 501.
Testing:	Test in accordance with this Section and Sections 26 05 00.

Cable System Identification: VFD3

Description: Large HP shielded motor cable for VFD drives.

Voltage: 600V

Conductor: Class B finely stranded tinned copper 1 awg through 500 kcmil

Provide pilot or control conductors integral to VFD cable as described in the circuit schedule, shown on the drawings or as required for individual applications.

Insulation: 90 degree C dry or wet, cross-linked polyethylene XPLE in accordance with NEMA.

Assembly: Individual conductors cabled together with barrier tape, longitudinal copper tape inside specially formulated thermoplastic elastomer (TPE) black jacket.

Jacket: TPE black jacket UL listed to -25 deg C, UL TC-ER listed. Minimum bend radius of 15x overall cable diameter. UL 1277, UL 44 listed.

Flame Resistance: IEEE 383

Manufacturer(s): Olflex VFD 2XL

Beldon 295XX

SAB Cables – VFD Combo XLPE (includes up to 2 pr of control conductors)

or approved equal.

Uses Permitted: Cable tray, conduit, exposed in normal or Class 1, Div 2 environment.

Execution:

Installation: Install in accordance with this Section

Provide cable seals where required by NEC 501.

Testing: Test in accordance with this Section and Sections 26 05 00.

Cable System Identification: CORD

Description:	Portable Cord, 3-conductor with ground, extra hard usage, oil, weather and water resistant. 10 AWG and smaller, UL listed, type SOOW; larger than 10 AWG, UL listed type G
Voltage:	600 volts
Conductor Material:	Type G - Flexible rope lay stranded per ASTM B189 and B33. Type SOOW – Soft bare annealed copper per ASTM B-3, flexible bunch strand per ASTM B-174.
Insulation:	Insulation shall be ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
Jacket:	Black chlorinated polyethylene (CPE) rubber ICEA S-98- 658.
Manufacturer(s):	Type SOOW - Houston Wire HW250, Southwire Viper, or approved equal. Type G – Houston Wire HW258, Southwire Type G, or approved equal,

Execution:

Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with Sections 26 05 00.
Sizing Cables:	Cables shall be sized for loads to be served.

Cable System Identification: INS

Description:	Single twisted, shielded pair or triad, 18 AWG, instrumentation cable, rated for wet and dry locations.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Insulation:	PVC/Nylon
Shield:	100 percent, 1.35 mil aluminum-Polyester tape with 20 AWG 7-strand tinned copper drain wire
Jacket:	48 mil flame-resistance polyvinylchloride
Flame Resistance:	UL 1685, ICEA T-29-520 and IEEE 1202.
Manufacturer(s):	Single Pair: BELDEN 1120A, or approved equal. Single Triad: BELDEN 1121A, or approved equal.

Execution:

Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00.

Cable System Identification: INS/M

Description:	Multiple twisted, shielded pairs or triads, instrumentation cable, rated for wet and dry locations.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8
Lay:	Length 2.5 inches
Insulation:	PVC/Nylon
Shield:	100 percent, 1.35 mil aluminum-Polyester tape with 18 AWG 7-strand tinned copper drain wire
Jacket:	48 mil or 68 mil or 84 mil flame-resistance polyvinylchloride
Flame Resistance:	UL 1685and IEEE 1202.
Manufacturer(s):	2 pair: BELDEN 1048A, or approved equal. 4 pair: BELDEN 1049A, or approved equal. 12 pair: BELDEN 1051A, or approved equal 4 triad: BELDEN 1093A, or approved equal. 12 triad: BELDEN 1095A, or approved equal.
Execution:	
Installation:	Install in accordance with Section 26 05 19.
Testing:	Test in accordance with this Section and Sections 26 05 00.

Cable System Identification: NC2

Description:	Paired – MediaTwist Enhanced Category 6, gigabit Ethernet, 100BaseTX, 4 pair cable, non-armored
Voltage:	300V rms
Conductor Material:	Tinned copper 24 AWG
Insulation Material:	Polyolefin (PO)
Shield:	Unshielded
Jacket:	Polyvinyl chloride (PVC), 0.365x0.165-inch diameter
Flame Resistance:	UL 1666 riser
Electrical Characteristics:	350 MHz, 51.1 dB/100 meters
Manufacturer(s):	Belden 1875GB, Okonite, or approved equal.
Uses Permitted:	Conduit.

Execution:

Application:	Data Network Communications – Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

Cable System Identification: NC3

Description:	Category 6, gigabit Ethernet, 4 pair cable, shielded
Voltage:	300V rms
Conductor Material:	Solid bare copper 23 AWG
Insulation Material:	Polyolefin (PO) + Fluorinated Ethylene Propylene (FEP)
Shield:	Shielded, Polyester + Bi-Laminate (Alum+Poly) 100 percent coverage with solid drain wire
Jacket:	Polyvinyl chloride (PVC), 0.290-inch diameter
Flame Resistance:	UL 1666 riser
Electrical Characteristics:	250 MHz, 22.0 dB/100 meters
Manufacturer(s):	Belden 1351A, Okonite, or approved equal
Uses Permitted:	Conduit.

Execution:

Application:	Data Network Communications – Shielded Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer's instruction.
Testing:	Test in accordance with this Section.

Cable System Identification: NC4

Category 6, gigabit Ethernet, 4 pair cable, shielded

600V rms

Solid bare copper 23 AWG

Polyolefin (PO) + Fluorinated Ethylene Propylene (FEP)

Shielded, Polyester + Bi-Laminate (Alum+Poly) 100 percent coverage with solid drain wire

Polyvinyl chloride (PVC), 0.290-inch diameter

UL 1666 riser

250 MHz, 22.0 dB/100 meters

Belden 1351A, Okonite, or approved equal

Conduit.

Data Network Communications – Shielded Ethernet.

Install in accordance with this Section and associated equipment manufacturer's instruction.

Test in accordance with this Section.

Cable Identification: FOT-MM

Description: Multimode fiber-optic cable; Tight-buffer, Dual Layer, with 6-strand or 12-strand fibers as shown on drawings:

Outdoor/Indoor; Riser Rated; Cable Tray Rated

Loose tube construction. Optical fibers shall not adhere to the inside of the buffer tube.

Fibers and buffer tubes shall be color coded with distinct and recognizable colors in accordance with EIA/TIA-598.

Jacket: PVC extruded under high pressure directly over the cable core such as to produce cusped ridges that interlock with the subcables

Color: Black

Mark the exterior sheathing with the manufacturer's name, month and year of manufacture, and sequential meter or foot markings for easily determining the length of the cable at all points along the cable run.

Type: OFNR with industrial cable tray rating and IEEE 383 Chapter 8 flame test rated
Fiber Type: Multimode
Clad Diameter: 125 $\pm$ 0.7 μm
Coating Diameter: 245 $\pm$ 5 μm Core Diameter: 62.5 μm
Attenuation: $\leq$ 0.35 db/km @ 1310 nm
$\leq$ 0.25 db/km @ 1550 nm
Operating Temperature Range: -50 to +75 Deg C
Maximum Tensile Loading: 670/270 lbs (Installation/Operating)
Minimum Cable Bending Radius: 5.7”/3.8” (Installation/Operating)

Manufacturers: Optical Cable Corporation BX-series or approved equal

(1) Fiber Optic cable shall be suitable for installation in conduit runs within buildings.
(2) Fiber Optic cable shall be suitable for installation between buildings in outdoor conduit runs which share vaults with 600-volt cable.
(3) The contractor shall use zip cord jumper cables between patch/breakout panels and communications equipment.
(4) Fiber shall be terminated with ST style connectors unless otherwise shown on drawings or required by the submitted equipment manufacturer.
(5) Fiber Optic cables shall have number of fibers as shown in the documents.

(6) The cable that connects PLC to the Fiber Optic interface shall be Belden 9841 or approved equal.

Execution:

Application: Data communication.

Installation: Install in accordance with this Section and associated equipment manufacturer's instruction.

Testing: Test in accordance with this Section.

Cable System Identification: IT

Description:	DataTuff Enhanced Category 6, gigabit Ethernet, 100BaseTX, 4 bonded pair cable, non-armored
Voltage:	300V rms, or 600V rms
Conductor Material:	Bare copper 23 AWG solid.
Insulation Material:	Fluorinated Ethylene Propylene (FEP)
Shield:	Unshielded for 300V application, Bi-Laminate (Alum+Poly) 100% shielded for 600V application
Jacket:	Fluorinated Ethylene Propylene (FEP), 0.214-inch diameter for 300V application and 0.335-inch diameter for 600V application.
Flame Resistance:	UL 723, NFPA 262 for 300V application, UL 16666 for 600V application
Electrical Characteristics:	250 MHz, 32.8 dB/100 meters
Manufacturer(s):	Belden 7931A – 300V, Belden 7953A – 600V, or approved equal.
Uses Permitted:	Conduit, Tray, In-cabinet
Execution:	Use 600V for MCC, Motor Control cabinets or other applications in close proximity to 480V circuiting or where “noise” could be an issue.
Application:	Data Network Communications – Ethernet.
Installation:	Install in accordance with this Section and associated equipment manufacturer’s instruction.
Testing:	Test in accordance with this Section.

END OF SECTION

SECTION 26 05 26 - GROUNDING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. System Requirements.
5. Sizing.
6. Submittals.
7. Products.
8. Execution.

1.2 SCOPE

A. This section specifies the system for grounding electrical distribution and utilization equipment, including but not limited to cabinets, motor frames, manholes, instrumentation, metal surfaces of process/mechanical equipment that contain energized electrical components, metal structures and buildings, outdoor metal enclosures, fences and gates.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 81.2-1991	Guide to Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems
NETA - ATS	Inter-National Electrical Testing Association Inc. - Acceptance Testing Specifications
NFPA 70	National Electric Code (NEC) Article 250

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SYSTEM REQUIREMENTS

A. Provide equipment grounding conductors in all electrical raceways. The conductors shall be sized in accordance with the National Electrical Code.

B. Underground, rebar, and building steel ground connections shall be via exothermic weld or hydraulically die crimped cold weld.

C. Bond building's rebar and building steel attributes to form a ground mat. Bond all site ground mats via exothermic weld or hydraulically die crimped cold weld.

D. Provide cable tray grounding and bonding in accordance with these project specifications and the drawings.

1.6 SIZING

A. SIZING: The minimum size of the Equipment Grounding Conductors installed with the circuit conductors shall be per the National Electrical Code Table 250.122. The circuit grounding conductor size routed with a feeder or branch circuit conductors is as shown on the drawings.

1.7 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Marked product literature for ground rods, test wells, and equipment ground plate.

4. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

5. Marked product literature for ground rods, test wells, and equipment ground plate.

6. Grounding system test data.

7. Maintenance Data: For all equipment and for components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 77 00 - Project Closeout and 01 78 23 - Operations and Maintenance Data include the following:

   a. Routine maintenance requirements for equipment and components.

PART 2 PRODUCTS

2.1 PROCESS EQUIPMENT GROUNDS

A. The contractor shall coordinate with the equipment supplier to provide an equipment ground lug and contractor provided ground cable and terminations to bond the equipment to the grounding electrode system. Ground cable shall be sized in accordance with this specification. Provide cables, exothermic welds, hydraulic die crimp connections and equipment bolted connections as necessary.

2.2 GROUND CONDUCTORS

A. The System Ground Conductor shall be soft-drawn, bare annealed copper, concentric stranded, as specified. The minimum sizes shall be as follows, where American Wire Gage (AWG) conductor sizes are not shown or specified:

15 kV-5 kV transformers	4/0 AWG
480V switchboards	4/0 AWG
480V MCC	4/0 AWG
ATS and MTS	2/0 AWG
Cable tray	2/0 AWG
Lighting & Power panels	2 AWG
Exposed metal cabinets	2 AWG
Electrical & Process equipment	2 AWG
Buildings and enclosure	2 AWG
Fences and gates	2 AWG
Motors 25 HP to 250 HP	2 AWG
Motors 1 HP to 25 HP	6 AWG

2.3 GROUND RODS

A. Ground rods shall be copper covered steel, 3/4-inch diameter and 10-feet long. Rods shall have threaded type removable caps so that extension rods of same diameter and length may be added where necessary.

2.4 CONNECTORS

A. COMPRESSION CONNECTORS: Compression connections shall be irreversible, cast copper as manufactured by Thomas and Betts, or approved equal.

B. BOLTED CONNECTORS: Bolted connectors shall be Burndy, O. Z. Gedney, Thomas and Betts, or approved equal.

C. EXOTHERMIC WELDED CONNECTORS: Exothermic welding products shall be Erico's Cadweld Plus system with a remotely operated battery powered electronic ignition device and moisture resistant weld metal cup for the required mold, or approved equal.

D. COLD WELDED CONNECTORS: Hydraulically die crimped cold weld connectors shall be cast copper compression cross grid type as manufactured by Burndy, or approved equal.

2.5 TEST WELLS

A. CONCRETE BOXES

1. Material: High density reinforced concrete box with non-settling shoulders positioned to maintain grade and facilitate back filling with steel checker plate screw down cover.

2. Product and Manufacturer: Provide box assembly from one of the following:

a. Concrete Box: Christy Concrete Products, Inc. Model #B1017 or Approved Equal.

b. Steel Cover: Christy Concrete Products, Inc. Model # B1017-51JH labeled "GROUND" or Approved Equal.

B. EXTERIOR TEST WELL: Provide concrete test well with cover and connect the ground grid extension using a removable connector.

2.6 EQUIPMENT GROUND BARS

A. Ground bars required in power distribution equipment shall be tin plated copper and sized in accordance with manufacturer's standard.

B. Copper equipment ground bars shall be Erico Eritech EGB Series or approved equal, sized as required for the installation.

C. Ground bars shown in electrical rooms or adjacent to electrical equipment shall be tin plated copper and shall be wall mounted at 18 inches above finished floor on isolation standoffs. Unless otherwise specifically sized, the ground bars shall be 30 inches long, 4 inches tall and ¼ inches thick. Bars shall have pre-drilled 7/16" holes for termination of lugged conductors. Ground bars shall be Storm Copper, Alpha Equipment Company isolated ground bar assembly, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Embedded and buried ground connections shall be made by exothermic or irreversible cold weld connectors. Above grade ground connections shall be made by exothermic weld or by utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Tools and dies shall be approved for this purpose; dimple compressions are not acceptable. Compression connections shall be prepared in accordance with the manufacturer's instructions. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise specified. No solder shall be used in any part of the ground circuits.

B. Embedded ground cables and fittings shall be exothermically or cold weld bonded to concrete reinforcing steel. Ground wires shall also be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.

C. Grounding conductors, which are extended beyond concrete surfaces for equipment connection, shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet. Grounding conductors, which project from a concrete surface, shall be located as close as possible to a corner of the equipment pad, protected by non-metallic conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals or less. Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate.

D. Ground conductors, except signal conductor shields, entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure. Prior to making ground connections or bonds, the metal surface at the point of connection shall be cleaned.

E. Compression-type lugs shall be used in accordance with manufacturer's recommendations.

F. Grounding conductor shall not be used as a system neutral.

G. Surge arresters shall be directly connected to the ground system using copper conductors, sized as specified.

H. Metallic sheaths or shields of shielded power cable shall be terminated by a copper grounding strip provided with cable connection for connection to the grounding system. Grounding strip shall be sized to withstand available fault current for specimen to be terminated.

I. Furnish an equipment grounding conductor in all conduit runs sized in accordance with the NEC.

J. Grounding system shall be provided in compliance with the NEC.

K. Metallic sheaths or shields of shielded power cable shall be terminated by a copper grounding strip provided with cable connection for connection to the grounding system.

L. Bond building service piping systems to ground within three feet of entering the building.

3.2 RACEWAY GROUND

A. All service, feeder and branch circuit raceways shall contain a green insulated ground conductor sized per applicable NFPA 70 National Electrical Code (NEC) tables:

1. T250.66 - Grounding Electrode Conductor for Alternating-Current Systems or

2. T250.122 - Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment.

B. Metallic conduits terminating at concentric knock-outs or reducing washers shall be bonded using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with NEC.

C. Provide equipment grounding conductors in all power and control circuit raceways.

3.3 EQUPMENT AND ENCLOSURE BONDING

A. Electrical distribution and utilization equipment enclosure ground bus, motor frames, manholes, metal structures and buildings, outdoor metal enclosures, fences and gates shall be bonded to the grounding system with conductor sizes as specified.

B. Connect the conductor to the metal enclosure using a UL listed connector, where the enclosure does not contain an internal ground bus.

C. Non-electrical equipment with metallic enclosures that are located outdoor, and without a cover or a shade, shall be connected to the grounding system.

3.4 ISOLATED GROUNDING

A. An isolated ground system shall be installed where required by an equipment manufacturer. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors. The isolated ground bus shall be kept isolated from neutral and grounding buses.

B. Where specifically directed by the Owner and required by an equipment manufacturer, the Contractor shall provide an additional isolated ground conductor from the service or separately derived system to an isolated ground bus bar at each associated distribution point.

C. The neutral conductor from the ultra-isolation transformers shall be grounded only at the single point ground bus in the automatic transfer switch.

3.5 SERVICE AND SEPARATELY DERIVED SYSTEM BONDING

A. A neutral bonding jumper shall be installed in only one location for each service or separately derived system. The bonding jumper shall be located at the service source or the first immediate distribution point downstream from the source. The neutral and ground buses shall be kept isolated from each other except where the bonding jumper is installed.

3.6 GROUNDING SYSTEM TESTS

A. The Contractor shall test the facility grounding system and the building grounding system to determine the ground resistance. The grounding test shall be IEEE Standard 81 using the NETA Fall-of-Potential procedure. A plot of ground resistance readings for each isolated ground rod, ground mat, or ground bus shall be submitted on 8-1/2 x 11-inch size graph paper. Point-to-point resistance measurements are not acceptable.

1. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test or as recommended by IEEE Standard 81. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

2. A grounding system that shows greater than 2-ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded.

3. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2-ohm requirement. Additional ground rods will be paid for as extra work where the required numbers exceed that specified when authorized and approved by the Construction Manager.

4. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. This Section specifies requirements for design, furnishing and installation of support systems for electrical raceways, cables and enclosures.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM A48 REV A	Gray Iron Castings
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated

Reference	Title
FEDSPEC W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE1	Cable Tray Systems
NEMA VE 2	Cable Tray Installation Guidelines
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 651	Rigid Nonmetal Electrical Conduit
UL 797	Electrical Metallic Tubing

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

    d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

4. Supports, seismic bracing, and other electrical system mounting elements are generally not shown on the plan drawings. Hangers, supports, seismic restraints, and other electrical system mounting elements shall be submitted in accordance 01 41 20.

PART 2 PRODUCTS

2.1 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS

1. Framing channel with end caps and straps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole pipe straps used with clamp backs and nesting backs where required. Material as specified herein.

2. Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel clamps or oversized stainless-steel clamps.

B. CEILING HANGERS: Ceiling hangers shall be adjustable steel rod hangers and fittings. Provide J-Type conduit support for single conduit. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise shown, hanger rods shall meet ASTM A193 and be sized as 3/8-inch up to 2-inch conduit and shall be 1/2-inch all-thread rod over 2-inch conduit. Material as specified herein.

C. SUSPENDED RACEWAY SUPPORTS AND RACKS:

1. Suspended raceway supports shall consist of concrete inserts, steel rod hangers, and jam nuts supporting framing channel or lay-in pipe hangers as required. Framing channel shall be a minimum of 12-gauge. Material as specified herein.

2. Hanger rods shall be a minimum of 1/2-inch diameter all-thread rod and shall meet ASTM A193. Suspended raceway supports and racks shall be braced for seismic forces as specified in Section 01 41 20.

D. MATERIALS: Table A specifies the type of raceway supports required for each location and application.

Table A

Location	Framing Channel and Accessories	Threaded Rod, Hardware, & Fittings
Indoor Dry	Zinc Plated Steel	Zinc Plated Steel
Indoor, Wet	316 Stainless Steel	316 Stainless Steel
Outdoor	316 Stainless Steel	316 Stainless Steel
Submerged	316 Stainless Steel	316 Stainless Steel
Headspace	316 Stainless Steel	316 Stainless Steel

Chemical Corrosive	316 Stainless Steel	316 Stainless Steel
Process Corrosive	316 Stainless Steel	316 Stainless Steel

2.2 EQUIPMENT SUPPORTS

A. Equipment supports shall be installed where shown on the drawings and as required to support the panels and enclosures being installed.

B. Equipment support materials shall adhere to Table A above unless specified otherwise on the drawings.

C. Equipment supports shall be installed per details in the Construction Documents.

2.3 ANCHOR BOLTS

A. Anchor bolts shall be as specified in Section 05 50 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Hangers and supports shall be installed with spacing between support points in compliance with all applicable codes.

B. The cut ends of support channels shall be smoothed and without burrs left from cutting.

END OF SECTION

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SECTION 26 05 33 - RACEWAYS, BOXES, AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Installation.
7. Raceway Specification Sheets.

1.2 SCOPE

A. This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, electrical vaults, hand holes, and fittings. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation

FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. Listing and Labeling: Provide raceway and boxes that are Listed and Labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authority Having Jurisdiction, and marked for intended use for the location and environment in which they are installed.

C. Comply with NECA's "National Electrical Installation Standards."

D. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

1.6 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

PART 2 PRODUCTS

2.1 RACEWAY

A. General requirements for raceway materials specified in this section are listed in the RACESPECS sheets at the end of this section. The type of raceway to be used for any given area and application shall conform to the requirements of Table A in this section.

2.2 BOXES AND FITTINGS

A. PULL BOXES AND WIRING GUTTERS: Indoor boxes above grade and in unclassified indoor areas shall be NEMA 12 with hinged doors. Similar enclosures for below grade

and outdoors shall be rated NEMA 4X (Type 316 stainless steel) with hinged doors. Boxes in hazardous classified areas shall be rated for the classification, NEMA 7. Box covers shall be provided with hinged doors with quick release latches and oil resistant gaskets. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction and pull box covers are not allowed.

B. TERMINAL CABINETS: Terminal cabinets located indoors and in unclassified indoor areas shall be NEMA 12. Cabinets located below grade, outdoors, and in corrosive or damp areas shall be NEMA 4X (Type 316 stainless steel). Cabinets in hazardous classified areas shall be rated for the classification, NEMA 7. Cabinets shall be provided with hinged doors with quick release latches. Adjustable terminal strip mounting accessories shall be provided. Cabinets shall be provided with channel mounted terminal blocks rated 30 amperes, 600-volt AC. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals. Hoffman type CHQR, or approved equal.

C. PULL/JUNCTION BOXES:

1. Indoor boxes above grade and in unclassified indoor areas shall be NEMA 12 with hinged doors. Similar enclosures for below grade and outdoors shall be rated NEMA 4X (Type 316 stainless steel) with hinged doors. Boxes in hazardous classified areas shall be rated for the classification, NEMA 7. Pull and junction boxes for use in raceway systems with conduits 1-1/4" or larger shall be hinged boxes with 2 screw driver operable or quick release latches. Minimum depth of box shall be 5.3", the minimum size shall be as shown on the drawings or as required for the application or NEC. Hoffman type CH or approved equal. For damp, below grade, outdoor, or corrosive applications provide Hoffman type CHFNFSS or approved equal.

2. For Hazardous areas provide Cast copper free aluminum box with neoprene gasketed screw on cover. Crouse-Hinds GUE, GUB, or approved equal.

D. ELECTRICAL VAULTS:

1. Electrical vaults shall be precast concrete with covers designed for H-20 loading. Dimensions shall be as specified on the standard details. Electrical vaults shall be provided with precast solid concrete slab bottoms with sumps as indicated, and a 3 inch by 2-foot-long copper ground bar. Electrical vaults shall be constructed of 3000 psi reinforced concrete. Manhole covers shall be engraved "ELECTRICAL", "CONTROL" or "SIGNAL" as applicable.

2. Manhole covers shall be hinged and watertight unless otherwise indicated on the drawings. Hinged covers shall be made of aluminum and provided with a locking latch. Covers shall be made for easy opening and latching and be provided with a mechanism that shall hold the cover in the open position at 90 degrees, and

provided with spring-assist openers. Manhole covers shall be bonded to ground bar via flexible copper braid or self-grounding connections.

3. Electrical vaults shall be provided with pulling irons and galvanized cable racks on each wall. Cable racks shall utilize porcelain cable supports. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolted to permanent wall surfaces with anchors or continuous slot concrete inserts.

4. Electrical vaults shall be per the size indicated in the contract drawings and include a H-20 loading where shown on the drawings. Oldcastle or approved equal.

E. HAND HOLES:

1. Hand holes shall be per the size indicated in the contract drawings and include a H-20 loading where shown on the drawings. Hand holes shall be engraved with “ELECTRICAL”, “CONTROL” or “SIGNAL” as applicable.

2. Unused conduits shall be provided with conduit seal caps.

2.3 RACEWAY SUPPORTS

A. All support systems for electrical systems shall be as specified in Section 26 05 29.

2.4 CONCRETE ENCASED DUCT BANKS

A. Concrete used for duct banks shall be Class E with red iron oxide added as specified in the Cast-in-Place Concrete section. Rebar if required, shall be as indicated on the drawings.

1. Red Oxide shall be added to concrete in compliance with ASTM specification C-979-82.

2. Typical dosing of iron oxide shall be approximately 10 lbs. per cubic yard of concrete or as determined appropriate by the concrete supplier to mee ASTM C-979-82.

2.5 UNDERGROUND MARKING TAPE

A. Underground marking tape shall be for early warning protection of digging around reinforced concrete duct banks. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness. The plastic color shall be red. A warning shall be imprinted continuously along the length, with message reading similar to “CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW.” Tape shall be Brady “Identoline,” Services and Materials “Buried Underground Tape,” Somerset (Thomas & Betts) “Protect-A-Line,” or approved equal.

B. Underground marking tape for directly buried cables and conduits shall be 6-inch wide metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. The message shall be clearly printed with black over red tape and shall read “CAUTION ELECTRIC LINE BURIED BELOW.”

2.6 NAMEPLATES

A. Nameplates shall be provided for all pull and junction boxes in accordance with the requirements of Section 26 05 00. Nameplate numbering shall be as indicated on the drawings. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate or as required by the Engineer and Owner. Any nameplates provided where the wording is not specified shall first be approved by the Engineer and Owner.

2.7 FIRESTOPS

A. Raceway penetrations through masonry walls shall be mortared to seal penetration’s air gaps. Raceways penetrations through other walls shall utilize an approved elastomer product to seal up all air gaps.

PART 3 EXECUTION

3.1 INSTALLATION:

A. Table A specifies the type of raceway required for each location and application. Unscheduled conduit, (i.e. lighting, convenience outlets, etc.), not shown on the drawings shall be in accordance with Table A below.

Table A

Location	Application/Condition	RACESPEC
Indoor Dry	Exposed	GRS
Indoor Wet	Exposed	PGRS
Outdoor	Exposed	PGRS
Concealed	Power circuits embedded in concrete structure or beneath slab-on-grade	PVC4
Concealed	Instrumentation, communications and data signals encased in concrete, duct bank	PGRS
Underground	Power circuits encased in concrete, duct bank	PVC4
Underground	Power circuits directly buried	PVC4
Underground	Instrumentation, communications and data signals directly buried	PVC4

Nonhazardous	Final connection to equipment and light fixtures	LFS
Corrosive	Exposed	PGRS
Hazardous corrosive	Exposed	PGRS
Architecturally finished areas	Final connection to light fixtures	FLEX

3.2 CONDUIT

A. GENERAL:

1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

3. Provide pull and junction boxes per code. When shown on drawings, box or manhole sizes shall be considered to be minimum sizes and shall be upsized by the Contractor for ease of pulling wire or if required by NEC.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

1. In general, Contractor shall be responsible for determining conduit routing that conforms to the specified installation requirements:

   a. Conduits for lighting and outlets: exposed
   b. Conduits for lighting and outlets: concealed
   c. Conduits for process equipment: exposed
   d. Conduit inside structures: exposed
   e. Conduit concealed inside water chambers slabs and walls: not permitted.

2. Existing conduit installations may be utilized provided the installation meets the following requirements:

   a. The installation meets the project specifications.
   b. The raceway meets the minimum National Electrical Code (NEC) requirements.
   c. The raceway is re-labeled per the project raceway schedules.

3. Conduit installation shall conform to the requirements of the RACESPEC sheets and the following specified installation requirements:

   a. Exposed conduit: Install parallel or perpendicular to structural members and surfaces. Install conduit horizontally and allow minimum headroom of 7 feet.

b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.

c. Maintain minimum spacing between exposed parallel conduit and piping runs in accordance with the following when the runs are greater than 30 feet:

   1) Between instrumentation and telecommunication: 1 inch

   2) Between instrumentation and 125 VDC, 48 VDC, and 24 VDC: 2 inches

   3) Between instrumentation and 600 VAC and less power: 6 inches

   4) Between instrumentation and 600 VAC and greater power: 12 inches

   5) Between telecommunication and 125 VDC, 48 VDC, and 24 VDC: 2 inches

   6) Between telecommunication and 600 VAC and less power: 6 inches

   7) Between telecommunication and 600 VAC and greater power: 12 inches

   8) Between 125 VDC, 48 VDC, and 24 VDC and 600 VAC and less power: 2 inches

   9) Between 125 VDC, 48 VDC, and 24 VDC and 600 VAC and greater power: 2 inches

   10) Between 600 VAC and less power and 600 VAC and greater power: 2 inches

   11) Between process, gas, air and water pipes: 6 inches

d. Space exposed conduit installed on supports not more than 10 feet apart. Space multiple conduits in parallel and use framing channel.

e. Comply with the requirements of Section 26 05 00 and herein, where conduits are suspended from the ceiling.

f. Secure conduit rack supports to concrete walls and ceilings with cast-in-place anchors or framing channel concrete inserts.

g. Install conduits at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90-degree C.

h. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces.

i. Place conduits under the reinforcement in slabs with only a single layer of reinforcing steel. Separation between conduits, conduits and reinforcement,

and conduits and surfaces of concrete shall be maintained in accordance with IBC.

j. Route conduit clear of structural openings and indicated future openings.

k. Provide conduits with flashed and watertight seals routed through roofs or metal walls.

l. Grout conduits into openings cut into concrete and masonry structures.

m. Cap conduits or plug flush conduits during construction to prevent entrance of dirt, trash, and water. Cap or plug empty conduits designated as “future”, “spare”, or “empty” and include a pulling line accessible at both ends. Use anti-seize compound on cap and plug threads prior to installation.

n. Determine concealed conduit stubup locations from the manufacturer’s shop drawings. Terminate concealed conduit for future use in specified equipment.

o. Install conduit flush with structural surfaces with galvanized couplings and plugs. Caps and plugs shall match the conduit system.

p. Provide concealed portions of conduits for future equipment where the drawings indicate future equipment. Match the existing installation for duplicate equipment.

q. Terminate conduits that enter enclosures with fittings that match the NEMA rating of the enclosure.

r. Underground metallic or nonmetallic conduit that turn out of concrete, masonry or earth: Install a 90-degree elbow of PVC- coated rigid steel conduit before emergence above ground.

s. Provide O-Z Gedney “Type DX” or Crouse-Hinds “Type XD” bonded, weather-tight expansion and deflection fitting for the conduit size where conduit across structural joints that allows structural movement.

C. UNDERGROUND CONDUIT SYSTEM: Excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. Underground conduits shall be reinforced concrete encased under roadways or where otherwise exposed to possible damage or where adequate cover does not exist.

2. Concrete encased conduit shall have minimum concrete thicknesses of 2 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches between reinforcing and earth, unless shown otherwise in an electrical detail.

3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers and shall be not less than 3 feet elsewhere.

5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads protected. Steel surfaces shall be given two coats of epoxy paint.

6. Underground conduits and conduit banks shall have 2 feet minimum earth cover unless otherwise shown.

7. Underground conduit banks through building walls shall be cast-in-place or installed with concrete into boxouts with water stops on all sides of the boxout. Water-stops shall be as specified in the Cast-in-Place Concrete section. Extend the horizontal reinforcement from the duct bank into the boxout terminating with J-hook bends.

8. Conduits not encased in concrete and passing through walls with one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

9. Thoroughly swab conduits and raceways on the inside, immediately upon completion of pouring concrete.

10. After the concrete has set and before backfilling, pull a mandrel through each conduit. The mandrel shall have a diameter equal to the nominal conduit inside diameter minus 1/2 inch and shall not be less than 4 inches long.

11. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

12. Provide manufactured plastic conduit spacers anchored to prevent movement during the concrete pour. Manufacture: Carlon, PW Pipe, Underground Devices, or equal.

13. Backfill duct banks with clean fill compacted to 90-percent in 6-inch lifts after concrete has cured. Refer to Section 03 30 00 for concrete requirements including minimum 7 days of cure time prior to backfill over duct banks.

14. Provide PVC threaded adapter with female threads where PVC conduit is joined to steel conduit. Procedure:

    a. Before assembly: Double coat steel conduit with Red-Robroy, Green-Permacote, Blue-Ocal or approved equal product.

    b. After assembly: Seal with 65-mil thick, 2-inch-wide mastic sealing tape to 1/2-inch beyond threads. Products: 3M Scotch 2228; Plymouth 02625; or approved equal.

    c. Cover with 20-mil corrosion protection tape applied in 1/2-lap layers to 2-inch beyond threads. Products: 3M Scotchwrap 51; Plymouth Plywrap 12; or approved equal.

15. Provide PVC conduit with bell ends where duct banks terminate at walls, electrical vaults, or hand holes. Install bell ends flush with finished concrete.

16. Provide PVC conduit with bell ends where conduit rise below grade into a floor mounted electrical panel, electrical cabinet, MCC, or switchboard.

17. Separate power conduits from signal conduit within the same duct bank by 12” or greater separation where possible.

18. Separate high voltage duct banks from low voltage duct banks, where shown.

19. Provide wireways for transition from underslab conduits rising into wall- mounted panels where the number of conduits exceed the NEC allowable panel space in the bottom of the panel. Provide conduit sleeves or fitting for panel transition. Continuous thread or all-thread is prohibited.

D. ELECTRICAL VAULTS: Unless otherwise specified, electrical vaults installation shall be as follows:

1. Electrical vaults shall be provided in accordance with the drawings

2. Electrical vaults shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

3. Electrical vaults shall be set plumb, so that water shall drain properly to the sump.

4. Unless installed within a roadway, manhole pre-cast covers, unless otherwise specified, shall be set at 1 to 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

5. All metallic hardware inside electrical vaults shall be grounded by connection to the ground plate. Connections shall be made using bolted connections, bonding jumpers and grounding bushings.

6. Electrical vaults shall be supplied with a ground rod in accordance with 26 05 26.

7. Electrical vaults for medium voltage cabling shall require all racked MV cabling in vault to complete a 360 degree wrap around inside of vault before exiting.

E. CONDUIT IN BLOCK WALLS:

1. Install multiple runs of conduit that stub-up into a block wall and connect to recessed electrical panels with adequate space for the conduit. Coordinate the electrical work with the structural work and block installers to provide a chase to install the conduit. Install conduit in the cells that do not contain structural reinforcement. Install conduits in the center of the cell to avoid affecting the structural integrity of the wall.

2. Avoid conduit and electrical boxes installation that blocks the cell from being grouted or that blocks the cell reinforcing bars from being grouted. Avoid conduit in the first cell adjacent to doors, windows, corners and wall intersections and install conduits in the center of the first available cell a minimum of 1’-0” from the edge of these openings.

3. Where solid grouting of masonry walls is specified, install conduit and electrical boxes so as to provide sufficient space for grout to flow pass the boxes and conduit in order to fully fill the space beneath and behind. Where boxes need to be held in place, secure the boxes from the face of the block wall. Do not place items behind or next to electrical boxes to hold in place.

4. Coordinate split-face, slump and scored block installation with the masonry contractor to supply smooth face block at the location of receptacles and switches so that the device covers install flush to the wall. Install translucent weather-proof sealing material under device covers on outdoor or wet area locations.

F. CONDUIT SEAL-OFF FITTINGS:

1. Conduits passing:

   a. Between Class I, Division 1 area and Class I, Division 2 area; provide sealing fittings located at the boundary in accordance with NEC Article- 500.

   b. From hazardous or corrosive area into a non-hazardous or non-corrosive area.

   c. Install the seal-off material in the conduit seal-off fittings after inspection.

G. CONDUIT SEALING MATERIAL: Provide HYDRA-SEAL® Handi-Polyurethane-Foam or approved equal product to seal conduits and inner ducts.

1. Sealing product required features

a. Compatible with common cable jacket materials.
b. ASTM E-84 flame spread requirements and UL Classified.
c. Pre-pressurized, portable, one-component closed-cell foam sealing system.
d. Dries tack-free within 15 minutes and cures within 24 hours.
e. Reacts with applied moisture or with ambient humidity.
f. Remove over-spray with acetone and remove cured foam mechanically

2. Application Criteria:

a. Apply in ambient temperatures between 60° to 100° F.
b. Apply bead onto clean surface.

3.3 ELECTRICAL VAULTS AND HANDHOLES

A. Unless otherwise specified, manhole and hand hole installation shall be as follows:

1. Electrical vaults shall be provided in accordance with the drawings.

2. Electrical vaults, hand holes, and pull boxes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

3. Electrical vaults and hand holes shall be set plumb so that water shall drain to the sump.

4. Manhole covers shall be hinged and flush with the manhole lid. Manhole lids shall be set at 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

5. Metallic hardware inside electrical vaults and hand holes shall be bonded to the ground plate or ground bus using bolted connections, bonding jumpers and grounding bushings.

6. Electrical vaults shall be supplied with a ground rod in accordance with 26 05 26.

3.4 RACEWAY NUMBERING

A. Each conduit shall be provided with a number tag at each end and in each manhole, hand hole, or pull box.

B. Within electrical vaults, glue raceway tag to manhole wall next to raceway penetration.

3.5 RACEWAY SCHEDULE

A. GENERAL: Raceways are scheduled on the drawings.

B. UNSCHEDULED RACEWAY:

1. With the exception of lighting and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules.

2. Unscheduled lighting and receptacle raceways shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

3.6 RACESPEC SHEETS

A. The following RACESPECS are included in Paragraph 3.7.

1. FLEX
2. GRS
3. LFS
4. PGRS
5. PVC4

3.7 RACEWAY SPECIFICATION SHEETS (RACESPEC)

A. RACEWAY SPECIFICATION SHEETS (RACESPEC) – FLEX

Raceway Identification	FLEX
Description	Flexible Steel Conduit
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	UL 1
Construction	Spirally wound galvanized steel strip with successive convolutions securely interlocked
Minimum size	½ inch
Fittings	Compression type
Other	FLEX shall be provided with an internal ground wire.

B. RACEWAY SPECIFICATION SHEETS (RACESPEC) – GRS

Raceway Identification	GRS
Description	Galvanized Rigid Steel Conduit (GRS).
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	ANSI and UL
Finish	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Minimum size	Unless otherwise specified, ¾ inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings	
Locknuts, Rings, Hubs	Hot-dip galvanized insulated throat with bonding locknut or ring. The hubs shall utilize a neoprene "O" ring and provide a watertight connection. O-Z Gedney, CHM-XXT, or approved equal.
Unions	Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or approved equal. Threadless fittings are not acceptable.
Conduit Bodies	40% Oversized conduit bodies (Similar to T&B Form 8): Ferrous alloy type with screw taps for fastening covers to match the conduit system. Gaskets shall be made of neoprene.
Boxes	
Indoor	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
Outdoor	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square.
Corrosive	NEMA 4X stainless steel or nonmetallic, as specified.
Hazardous	NEMA Class 7 cast ferrous.

(contd. below)

Raceway Identification	GRS
Elbows	
¾ ’’ thru 1 ½’’	Factory fabricated or field bent
2’’ thru 6’’	Factory fabricated only
Conduit Bodies (Oversized)	
¾ ’’ thru 4’’	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for conduit entrances
5’’ and 6’’	Electro-galvanized iron or cast-iron box
Expansion Fittings	Expansion fittings in embedded runs shall be watertight with an internal bonding jumper. The expansion material shall be neoprene allowing for 3/4-inch movement in any direction
Manufacturers	Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or approved equal
Installation	Rigid steel conduit shall be made up tight and with conductive thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs or framing channel. Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

C. RACEWAY SPECIFICATION SHEETS (RACESPEC) - LFS

Raceway Identification	LFS
Description	Liquidtight Flexible Steel Conduit.
Application	Final connection to equipment subject to vibration or adjustment.
Compliance	UL 360.
Construction	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum size	¾ inch, except for instruments where ½ inch is acceptable.
Fittings	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral O-ring seals around the conduit and box connection and insulated throat Provide forty-five and ninety degree fittings where applicable Provide PVC coated flexible conduit and fittings where the conduit system is PVC coated
Installation	Length of flexible liquidtight conduit shall not exceed 36 inches in length. Use conductive thread compound.

D. RACEWAY SPECIFICATION SHEETS (RACESPEC) – PGRS

Raceway Identification	PGRS
Description	Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated. Provide factory made and coated elbows.
Compliance	ANSI and UL. The PVC coated rigid galvanized steel conduit shall meet NEMA RN1-2005 and UL-6 PVC adhesion performance requirements.
Finish	PGRS shall be hot-dip galvanized rigid steel conduit as specified in 26 05 33-3.7 GRS, with a PVC Coating. The PVC coating shall be gray, minimum 40 mils thick, bonded to the outside and continuous over the entire length of the conduit except at the threads, and be free of blisters, bubbles, or pinholes. Thread protectors shall be used on the exposed threads of the PVC coated conduit A 2-mil coat of urethane enamel coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat.
Minimum size	¾ inch
Fittings	Similarly coated to the same thickness as the conduit and provided with Type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company Conduit and fittings shall be coated by the same company. Male threads on elbows and nipples, and female threads on fittings or conduit couplings shall be protected by application of urethane coating.
Covers	PVC coated covers shall have a NEMA 4X rating and stainless-steel hardware.
Conduit Bodies	40% Oversized conduit bodies with covers as specified above.
Hubs	Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded cast ferrous alloy. Hubs shall have the same PVC coating as the conduit and insulating grounding bushings. Hubs shall utilize a neoprene “O” ring and shall provide a watertight connection.

Boxes

Nonhazardous	Type FD cast ferrous with PVC coating for all device boxes and for junction boxes less than 6 inches square.
Hazardous	NEMA Class 4X stainless steel or nonmetallic for junction boxes 6 inches square and larger.
Manufacturers	Ocal Blue, Robroy Industries, Plasti-Bond, Perma-Cote, KorKap or approved equal.
Installation	Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the PVC-coated conduit manufacturer.
	Exposed conduit threads shall be covered by a plastic overlap coated and sealed per manufacturer's recommendations.
	Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.
	PVC coated conduit shall be supported away from the structure using PVC coated conduit wall hangers or PVC coated conduit mounting hardware.
	Damaged work shall be replaced.
Training	Installers shall be trained and certified in the proper installation techniques provided by the PVC-coated conduit system manufacture.

E. RACEWAY SPECIFICATION SHEETS (RACESPEC) – PVC4

Raceway Identification	PVC4
Description	Rigid Nonmetallic Conduit.
Application	Heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage.
Compliance	NEMA TC2, UL 651
Construction	Schedule 40, high-impact, polyvinylchloride (PVC).
Minimum size	¾ inch exposed; 1 inch embedded or encased
Fittings	PVC solvent weld type.
Boxes	
Indoor	NEMA Class 4, nonmetallic
Outdoor and corrosive	NEMA Class 4X stainless steel or nonmetallic for junction boxes 6 inches square and larger.
Manufacturers	NEMA Class 4X, nonmetallic
Installation	PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O ring. Joints shall be made with standard PVC couplings. PVC conduit shall have bell ends where terminated at walls and boxes.

F. RACEWAY SPECIFICATION SHEETS (RACESPEC) - WW

Raceway Identification	WW
Description	Wireway and Auxiliary Gutter: Match the conduit or raceway system specified and shown on the drawings. Minimum: Flanged, oil-tight type with hinged covers
Application	As shown on the drawings.
Compliance	JIC EMP-1
Finish	NEMA-1 and NEMA-12: Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces. NEMA 4X: Type 316 Stainless Steel. Smooth finished surfaces.
Sizes as shown	4 in x 4 in, 6 in x 6 in, 8 in x 8 in
Fittings	PVC solvent weld type.
Indoor non-corrosive area	NEMA-1, NEMA-12 or as shown on the drawings.
Outdoor and corrosive area	NEMA-4X or as shown on the drawings.

END OF SECTION

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SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Coordination.
7. Safety Requirements.
8. Delivery Storage and Handling.
9. Products.
10. Execution.

1.2 SCOPE

A. This section includes the requirements for trenching, backfilling and installation of underground ducts and ductbanks, and the design, fabrication, delivery and installation of pull boxes, handholes, manholes and vaults. The extent and location of "Underground Ducts and Raceways for Electrical Systems" Work is shown in the Contract Documents.

1.3 REFERENCE STANDARDS

A. ASTM (American Society for Testing and Materials)

B. NFPA 70 (National Fire Protection Association) - National Electrical Code

C. ODOT/APWA Specifications, Section 6-02.3

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 DEFINITIONS

A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth or concrete.

B. Ductbank: 2 or more conduits or other raceways installed underground in the same trench or concrete envelope.

C. Handhole/Pull Box: An underground structure provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing, operating or maintaining equipment or wiring or both.

D. Manhole: An underground utility structure, large enough for a person to enter, with facilities for installing, operating and maintaining submersible equipment and cables.

E. Vault: An underground structurally solid utility structure including all sides, top and bottom, where entry is limited to personal qualified to install, maintain, operate or inspect the equipment or cable enclosed. The enclosure may have openings for ventilation, personnel access, cable entrance, and other openings required for operation of equipment in the vault.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. Submit materials data in accordance with of Section 01 33 00 - Submittals. Furnish manufacturers' technical literature, standard details, product specifications, and installation instructions for all products.

C. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

D. Submittals shall include the following:

1. Product Data:

a. Duct-bank separators and components

b. Ducts, and accessories including elbows, end bells, bends, fittings and solvent cement

c. Vault, Manholes, Handholes, Pull Boxes and accessories

d. Warning tape and planks

2. Shop drawings:

a. Precast or Factory-Fabricated Underground Utility Structures:

1) Dimensioned plans, elevations, sections, details, attachments to other work, and accessories.

2) Duct entry provisions, including locations and duct sizes.

3) Reinforcement details.

4) Frame and cover design and manhole frame support rings.

5) Ladder details.

6) Grounding details.

7) Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

b. Factory-Fabricated Handholes, and Pull Boxes Other than Precast Concrete:

1) Dimensioned plans, sections, and elevations, and fabrication and installation details.

2) Duct entry provisions, including locations and duct sizes.

3) Frame and Cover design.

4) Grounding details.

5) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

6) Details, technical data and design calculations for frames and covers.

3. Quality Assurance and Testing:

a. Qualification data and test results from tests specified in “Quality Assurance” Article. Provide all information specified.

4. Duct-Bank Coordination Drawings as specified in “Coordination” Article.

5. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

6. Qualification Data: For Professional Engineer and testing agency responsible for testing nonconcrete handholes and boxes.

7. Inspection report for factory inspections, according to ASTM C 1037.

8. Record Documents: Show dimensioned locations of underground ducts, handholes, and manholes from nearest building or permanent structure.

1.7 COORDINATION

A. Show duct profiles and coordination with other utilities and underground structures. Include plans and sections, drawn to scale and show bends and locations of expansion fittings. Revise locations and elevations from those indicated as required to suit field conditions and ensure that duct runs drain to manholes and handholes. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined by field verification. Contractor shall coordinate all modifications with the Engineer prior to final installation.

1.8 SAFETY REQUIREMENTS

A. Comply with safety and protection requirements of Section 26 05 00 - Electrical Work – General.

B. Perform Work in accordance with the safety requirements of the Department of Labor Occupational Safety and Health Administration, Volume 36, Number 75, Part II, Subpart P, “Excavations, Trenching, and Shoring,” and with Section 7 of the Manual of Accident Prevention in Construction as published by the Association General Contractors of America, Inc.

C. Educate supervisors and employees on safety requirements and practices to be followed during the course of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Precast concrete handholes and pull boxes:

a. Utility Vault/Oldcastle Precast Group.

b. Utility Concrete Products, LLC.
c. Concast.
d. Or Approved Equal.

2. Fiberglass Handholes and Boxes:

a. Carson Industries LLC.
b. Christy Concrete Products.
c. Oldcastle Precast.
d. Quazite: Hubbell Power System, Inc.
e. Or Approved Equal.

3. Precast Manholes and Vaults:

a. Utility Vault / Oldcastle Precast Company.
b. Shaw PIPE; Division of Shawcor Co.
c. American Concrete.
d. Or Approved Equal.

4. Duct Sealing Compound:

a. Polywater.
b. Filoform.
c. Or Approved Equal.

2.2 CONDUIT AND DUCTS

A. Metallic Conduit:

1. Galvanized Rigid Steel Conduit (GRC): ANSI C80.1

2. PVC-Coated Rigid Steel Conduit: ANSI RN 1. Coating thickness shall be 0.040 inch, minimum.

B. Nonmetallic conduit: Use underground only for medium-voltage and low-voltage applications

1. Rigid Plastic Conduit: NEMA TC 2, UL 651A, Schedule 40 and Schedule 80 PVC, rated for use with 90°C conductors under all installation conditions and labeled for underground use.

2. Liquid-Tight Flexible Nonmetallic Conduit (LFNC): UL 1660.

C. Conduit Fittings:

1. Steel Fittings: Zinc-coated, cast malleable, ferrous metal, threaded fittings, with neoprene cover gasket on each fitting installed outdoors.

2. PVC Conduit and Tubing Fittings: NEMA TC 3. Provide PVC fittings for PVC conduit and suitable watertight connections where PVC conduit connects to galvanized steel conduit.

3. Seal Bushings: O.Z. compound bushing on each conduit entering a building from outside underground and on each conduit passing from one space into another, which is normally at a lower temperature.

4. Hubs: Appleton “Hub” or “Hub-U” series, Thomas & Betts “370” series, Or Approved Equal hub on each conduit terminating in a box where a hub was not previously provided.

5. Unions: Appleton Type “EC”, Thomas & Betts “Erickson Coupling” conduit unions, Or Approved Equal where necessary.

2.3 DUCT SUPPORT/SPACERS

A. Rigid PVC spacers selected to provide [3 1/2”] minimum duct spacings and concrete cover depths indicated, while supporting ducts during concrete pour. Refer to drawing details for additional duct spacing requirements.

2.4 PRECAST CONCRETE HANDHOLES AND PULL BOXES

A. Comply with ASTM C 858 for design and manufacturing processes.

B. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Walls and bottom shall be constructed to support rating of cover. Frame and cover shall form top of enclosure.

1. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

   a. Type and size shall match fittings to duct or conduit to be terminated.

   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

3. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

4. Drain hole in base, 2-inch minimum diameter.

2.5 HANDHOLES AND PULL BOXES OTHER THAN PRECAST CONCRETE

A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

1. Color: Gray.

2. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

3. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

4. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

5. Drain hole in base, 2-inch minimum diameter.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced concrete or cast iron.

C. Street Lighting: Reinforced plastic mortar designed and tested to temperatures of -50°F meeting ASTM D635-91 flammability test.

2.6 PRE-CAST MANHOLES AND VAULTS (AASHTO RATED)

A. Precast Concrete Units: Interlocking, mating sections complete with accessory items, hardware, and features as indicated on Drawings. Shall be capable of supporting designed loads that are expected at the installed location. Walls and floors shall be reinforced to support rated strength of covers. Include concrete knockout panels 1-1/2 to 2 inches thick for future conduit entrances and sleeves for ground rods.

B. Design structure according to ASTM C 858.

C. Structural Design Loading: See structural for loading information.

D. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.

2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

E. Ground Rod Sleeve: Provide a 3-inch PVC conduit sleeves in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct routed from the facility.

F. Joint Sealant: Continuous extrusion of asphaltic butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand the maximum hydrostatic pressures at the installation location with the ground water level at grade.

G. Source Quality Control: Inspect structures according to ASTM C 1037. Units shall be capable of supporting specified loads.

H. Drainage:

1. Provide two holes for drainage, two-inch minimum diameter, and provide at least two feet of gravel under manhole.

2.7 CAST-IN-PLACE MANHOLES AND VAULTS

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod. Structures shall be reinforced to support designed loads that are expected at the installed location. Manhole walls and floors shall be reinforced to support rated strength of cover.

B. Structural design loading for AASHTO - H20.

C. Drainage:

1. Provide two holes for drainage, two-inch minimum diameter, and provide at least two feet of gravel under manhole.

2.8 FRAMES AND COVERS

A. Handhole and Pull Box Covers:

1. Uncoated gray iron meeting ASTM A48, Class 35B or ductile iron meeting ASTM A536 Class 70-50-05 or 80-55-06.

2. Reinforced concrete or weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

a. Frame and Cover shall be capable of supporting designed loads see Structural for loading information.

3. Cover:

a. Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Cover Handle: Recessed.

c. Cover Hinges: Concealed, with hold-open ratchet assembly.

d. Cover to include insert of other devices to facilitate lifting.

e. Cover secured by tamper-resistant locking devices similar to REA or FARGO.

f. Machine cover-to-frame bearing surfaces.

g. Cast-in legend “ELECTRICAL”, “COMM” or “LIGHTING” as appropriate. Concealed hinges, with hold-open ratchet assembly.

h. Legend: Molded lettering, as indicated for each service.

B. Manholes and Vaults

1. Frames, Covers and Ring Components: Comply with structural design loading specified for manholes and vaults. See Structural for loading information.

2. Frame and Cover: Reinforced concrete or [uncoated gray iron meeting ASTM A48, Class 35B] or [ductile iron meeting ASTM A536 Class 70-50-05 or 80-55-06] capable of supporting designed loads.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

b. Provide lifting points on manhole covers.

c. Cover Legend:

1) Manhole ID welded on to cover.

a) For electrical power manholes, identification shall be “ELECTRICAL #” where # is the manhole number.

b) For telecom manholes, identification shall be “COMM #” where # is the manhole number.

3. Manhole Ring Components: Precast concrete rings with dimensions and strength matched to those of highway rated roof opening.

a. Mortar for Ring and Frame and Cover Joints: Strength to match rated cover.

b. Where required, seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

2.9 ACCESSORIES

A. Manhole and Vault Lifting Means

1. Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. 2-inch diameter eye, 1-inch by 4-inch bolt. Working load with 6-inch embedment in 4000 psi concrete: 13,000 pounds minimum tension.

2. Pulling and Lifting Irons in Floor: 7/8-inch-diameter, hot-dipped galvanized, bent steel rod, stress relieved after forming, and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000 pounds shear and 60,000 pounds tension.

B. Bolting Inserts for Cable Stanchions: Threaded precast channel inserts of hot-dipped galvanized or stainless steel; 3'-0" on center; 1/2-inch internal diameter by 2-3/4 inches deep, flared to 1-1/4-inch minimum at base. Tested ultimate pull-out strength: 12,000 pounds minimum.

C. Expansion Anchors for Installation After Concrete is Cast: Per section 05 05 19 – Post-Installed Concrete Anchors. Zinc-plated carbon steel wedge type with stainless-steel expander clip, 1/2-inch bolt size, 5300-pound rated pull-out strength, and 6800-pound rated shear strength minimum. Cast in-place inserts not allowed unless cast by vault manufacturer.

D. Cable Rack Assemblies – heavy duty non-metallic 50% glass reinforced nylon or other non-metallic material having equal mechanical strength, thermal resistance, chemical resistance, dielectric strength and physical properties.

1. Cable Stanchions: Nominal 36 inches high by 4 inches wide, with multiple arm mounting holes and recessed bolt mounting holes.

2. Cable Arms: Arranged for secure drop in attachment in horizontal position at any location on cable stanchion, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450 lb. minimum capacity to 20 inches with 250 lb. minimum capacity. Top of arm shall be nominally 4 inches wide and shall have slots along full length for cable ties.

E. Cable Support Insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.

F. Floor Grate: 1" thick PVC or HDPE Grate approximately the size of the floor.

G. Grounding: Ground per Section 26 05 26 – Grounding.

1. Ground Rods: Ensure rods are copper bonded 3/4-inch by 10-foot minimum.

2. Ground Rod Knock Out: 3-inch knock out for installation of ground rod.

3. Ground Rod Sleeves: 3-inch PVC conduit sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

4. Ground Wire: Stranded bare copper, #2 AWG minimum.

5. Ground connections shall be compression type connectors, bolted and clamped type.

H. Duct Sealing Compound: Non-hardening, re-enterable, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35°F. Capable of withstanding temperature of 300°F without slump, capable of withstanding minimum 22' of water, and chemically resistant to gasoline, oils, acids and bases. Adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

I. Mechanical Link Seals: for conduit entering vaults or buildings.

2.10 DUCTBACK CONCRETE

A. Material: Provide in accordance with Section 03 30 00 - Cast-in-Place Concrete and as follows:

1. Gravel: 3/8" maximum.

2. Slump: 4" maximum.

3. Compressive strength: 3,000 psi at 28 days.

4. Color: Dye ductbank concrete red.

a. Red Oxide shall be added to concrete in compliance with ASTM specification C-979-82.

b. Typical dosing of iron oxide shall be approximately 10 lbs. per cubic yard of concrete or as determined appropriate by the concrete supplier to mee ASTM C-979-82.

5. Reinforcing (except when GRC is used): Steel conforming to ASTM A15. Provide #4 rebar top and bottom, 2'-0" lap at splices (4 places minimum) and #4 @ 18" on center around perimeter with 3" minimum cover.

2.11 BACKFILL MATERIAL

A. Lower Trench Portion (surrounding ductbank): Sandy silt, clay silt, sand clay or other material free of stones and conglomerates larger than 2”

B. Upper Trench Portion (one foot above ductbank up to grade): On-site backfill material consisting of rock, soil or soil-rock mixture containing no rocks or lumps over 6”

C. Controlled density fill (CDF)

1. CDF shall be a mixture of Portland cement, fly ash, aggregates, water and admixtures proportioned to provide a non-segregating, self-consolidating and free flowing material which will result in a hardened, dense, non-settling and excavatable fill. CDF shall be batched to provide a flowing, non-segregating mix with a slump between 6” and 8”. CDF shall be batched and mixed in accordance with ODOT/APWA Specifications.

2. CDF shall be used as fill above utilities wherever non-settling backfill is required.

D. Select Native Fill: Unsaturated excavated earth free of rocks, broken concrete and debris 6” and larger, and compacted in 12” lifts to prevent settlement.

E. Reinforced Concrete Ductbanks:

1. Below Concrete Encasement: 6” minimum compacted 5/8” minus crushed rock.

2. Above Concrete Encasement: 3” minimum sand.

3. Upper Trench:

a. Areas Under Pavement: Controlled Density Fill.
b. Areas Not Under Pavement: Select Native Fill.

F. Direct-Burial Conduit

1. Initial Bedding: 3” of sand below conduits.

2. Secondary Bedding: Unsaturated excavated earth free of rocks, broken concrete and debris 2” and larger, and compacted to 6” minimum above conduits.

3. Upper Trench:

a. Areas Under Pavement: Controlled Density Fill.
b. Areas Not Under Pavement: Select Native Fill.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine site to review ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Existing Utilities: Locate all existing utilities in the area prior to performing any excavation.

C. Existing manholes and handholes within the construction zones shall be provided with a ¾" steel plate cover to maintain protections of the manhole lids and covers. This includes, but is not limited, to construction areas, staging areas, and haul routes.

3.2 EARTHWORK

A. Comply with OSHA safety standards for trenching, including stable slope and shoring requirements.

B. Depth: Refer to Drawings for trench depth requirements. Correct points of over-excavation using mechanically-compacted backfill to form a smooth trench bottom. Minimum cover according to NEC or City Standards whichever is more stringent.

C. Width: Excavate to minimum width consistent with stability of sides.

D. Slope: Slope trenches so that conduit and ducts drain toward manholes and handholes and away from buildings and equipment.

E. Rock Excavation: Where rock pad is used for conduit trench, overexcavate 6" below the ductbanks and refill and compact with selected backfill material of same composition.

F. Muck Excavation: Where muck or unstable material is encountered, over-excavate and backfill to attain proper grade with coarse sand, gravel, or Controlled Density Fill.

1. Stockpile backfill material in an orderly manner; a sufficient distance from the trench to avoid overloading trench banks.

G. Bedding: The entire bottom of the excavation is to be firm, stable, and at uniform density.

H. Excavating for Manholes, Vaults Handholes, and Pullboxes: Provide 12" minimum clearance between outer surfaces of unit and embankment or timber used for shoring.

3.3 CONDUIT AND DUCT INSTALLATION

A. Refer to Specifications and Drawings for conduit and duct materials. Where not specified otherwise, use metallic conduit above and underground.

B. Metallic Conduit: Only use as specified in Section 26 05 33 - Raceways and Boxes.

C. Nonmetallic conduit: Use underground only.

1. Underground in Reinforced, Concrete-Encased Ductbanks: For medium-voltage, low-voltage, and communication applications. Use Schedule 40 Rigid Plastic Conduit as standard. Use rigid steel conduit on turns 45° or greater. Use Schedule 80 Rigid Plastic Conduit under roadways.

2. Underground Direct-Burial: For low-voltage applications only. Provide rigid plastic conduit, NEMA TC 2, Schedule 40 PVC (except rigid steel under roadways and either rigid steel or Schedule 80 under roadways), with NEMA TC3 PVC conduit and tubing fittings.

D. Use PVC fittings for PVC conduit and suitable water-tight connections where PVC conduit connects to galvanized steel conduit.

E. Install conduit and ducts as indicated on Drawings and according to manufacturer's written instructions.

F. Slope: For ductbanks and conduits without profiles, pitch ducts a minimum slope of 0.5% to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions. For ductbanks with profiles, install the ductbank at the elevation as shown on the drawings.

G. Curves and Bends: For all conduit systems (medium-voltage, low-voltage and communication) use manufactured galvanized rigid steel elbows for stub-ups at equipment and at building entrances with a minimum radius of 36 inches. Where existing conditions may cause 36 inch sweeps to be exposed, 24 inch sweeps may be used with approval of the Engineer. Use manufactured long sweep bends with a minimum radius of 25 feet both horizontally and vertically at other locations. Do not exceed 20 degrees for field bends.

H. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

I. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches on center for 5-inch ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line

slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Core drill entrances where knockouts do not exist.

J. Under Slab: Use PVC conduit with and suitable water-tight connections. Use rigid steel sweeps and specified elsewhere in this section and transition to rigid at least 24" before stubbing up through concrete floors in all areas, exposed or within electrical equipment.

1. Conduits stubbing up inside of electrical equipment and terminating there may use PVC with the approval of the Engineer

K. Building Entrances: Transition from underground duct to rigid steel conduit 5 feet minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in ductbanks passing through disturbed earth near buildings and other excavations. Provide ductbank support at wall without reducing structural or watertight integrity of building wall.

2. Direct-Buried, Non-encased Duct Entering Non-waterproofed Walls: Provide a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between the conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.

3. Waterproofed Wall and Floor Entrances: Provide a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

L. Separation Between Direct-Buried, Non-Encased Ducts: Provide 3 inches minimum separation for like services, and 12 inches minimum between power and communication ducts.

M. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts or at 8 feet maximum, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concrete: Do not pour concrete until conduit installation has been approved. Spade concrete carefully during pours to prevent voids under and between conduits and at the exterior surface of the envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each

ductbank between manholes or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into the concrete on both sides of the joint near the corners of the envelope.

3. Reinforcing: Reinforce ductbanks where they cross disturbed earth and where indicated on Drawings.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and the concrete envelope can be poured without soil inclusions; otherwise, use forms.

5. Minimum Clearances Between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 12 inches between power and communication ducts.

6. Depth: Except as otherwise indicated in the contract drawings, install top of duct bank at least 24 inches below finished grade in non-traffic areas and at least 24 inches below finished grade in vehicular traffic areas.

N. Stub-Ups: Use rigid steel conduit for stub-ups through concrete to equipment. Install insulated grounding bushings at the conduit terminations. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 2 feet beyond the edge of the pad. Couple steel conduits to the ducts with adapters designed for the purpose and then encase the coupling with 3 inches of concrete.

O. Sealing: Provide temporary closure at all duct terminations in manholes and vaults installed in this Project. Use sealing compound and plugs to withstand a minimum of 15 psi hydrostatic pressure.

P. Pulling Cord: Install 100-pound- test nylon cord in installed ducts, including spares.

Q. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of ductbank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.4 BACKFILLING

A. Backfill only after all necessary inspections and tests have been performed.

B. Remove all debris, rocks, broken concrete, and formwork before backfilling trenches.

C. Use Controlled Density Fill under pavement areas or wherever non-settling backfill is required.

D. Deposit backfill in layers with materials described in Article “Backfill Material.” Uniformly spread and compact backfill with suitable power tampers to the density of the adjacent soil and in such a manner so as not to disturb the alignment of the conduit. If settlement occurs, refill, compact and smooth off to conform to the surface of the ground.

E. Restore surface features at areas disturbed by excavation, and reestablish original grades.

1. Replace removed sod as soon as possible after backfilling is completed.

2. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other Work.

3. Restore vegetation and provide necessary topsoil, fertilizer, lime, seed, sod, sprigging, or mulching.

4. Replace disturbed paving.

3.5 VAULT, MANHOLE HANDHOLE AND PULL BOX INSTALLATION

A. Install as indicated on Drawings according to manufacturer’s written instructions and ASTM C 891.

1. In areas which are subjected to vehicular traffic, install units’ plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

2. In areas which are not subject to vehicular traffic, install so that manhole lid is 2” above surrounding dirt or gravel, and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

3. Support units on a level bed of crushed stone or gravel, graded from the 1/2-inch sieve to the No. 4 sieve and compacted to the same density as the adjacent undisturbed earth.

4. Drainage: Where manholes have drain holes in the bottom, provide two feet minimum of gravel below the drain hole or provide a drain line to the nearest storm drain.

B. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated on Drawings. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

1. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for field-installed anchor bolts. Use a minimum of 2 anchors for each cable stanchion.

C. Train cables neatly around corners and secure to walls or ceiling using cable clamps with expansion anchors.

D. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

E. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling and in contact with enclosure, and with top surface secured to top of box cover frame. Bottom of ring shall rest on controlled density fill per Engineer of record.

1. Concrete: 3000 psi, 28-day strength with a troweled finish.
2. Dimensions: Minimum 10 inches wide by 12 inches deep or per Engineer of record.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 Grounding.

1. Handhole: Install two ground rods through floor in each medium voltage handhole and small manhole with top protruding 4” above floor.

2. Manholes and Vaults: Install four ground rods through floor in each medium voltage manhole with top protruding 4” above floor.

3. Ensure rods are copper 3/4 inch by 10 foot minimum.

4. Provide #4/0 ground wire in medium voltage ductbank.

5. Provide #4/0 bare copper ground wire in manhole, attached to wall, attached at 24 inches on center and mounted minimum 6 inches above floor.

6. Provide #2 stranded copper equipment ground minimum in each raceway in use.

3.7 IDENTIFICATION

A. Identify raceways, cables and equipment as specified in Section 26 05 53 - Electrical Identification.

3.8 TESTING AND CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2-inch greater than internal diameter of duct. Clean internal surfaces of vaults, manholes and handholes, including sump.

B. Duct Integrity: Swab out ducts with a mandrel 1/2 inch smaller in diameter than internal diameter of ducts.

C. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Coordination.
6. Products.
7. Execution.

1.2 SCOPE

A. This section includes identification of electrical materials, equipment, and installations. The extent and location of “Electrical Identification” Work is shown in the Contract Documents.

1.3 REFERENCE STANDARDS

A. NFPA 70E National Electrical Safety Code
B. NFPA 70 National Electrical Code
C. ANSI A13.1.,
D. ANSI Z535.4
E. 29 CFR 1910.144
F. 29 CFR 1910.145.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

    d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

C. Submittals shall include the following.

1. Product Data for each type of product specified.

2. Schedule of identification nomenclature to be used for identification signs and labels.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 LABEL TYPES

A. Manufacturer’s standard products with colors prescribed by ANSI A13.1, NFPA 70, and these Specifications. Only temporary markings that are removable without damaging finish are permitted on equipment.

1. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Install labels and nameplates parallel to equipment lines. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

2. Provide engraved laminated phenolic plastic or melamine label for equipment as noted below. Securely attach engraved labels with blunt end, self-tapping stainless-steel screws with blunt ends. Sheet metal screws are not allowed. Provide white letters on black background for normal power, white letters on red background for emergency power.

a. Provide 5/8-inch minimum height letters on the following equipment:

   1) Panelboards, provide labels and warning signs. Secure nameplates to inside surface of door where panel is recessed in finished locations.

   2) Switchboards/distribution centers, motor control centers and power centers, pad mounted transformers

   3) Secondary feeder breakers in distribution equipment

   4) Automatic and manual transfer switches. Labels shall include both normal and emergency source and load.

   5) Special equipment housed in cabinets, on outside door.

   6) Terminal junction boxes and data gathering panels

   7) Cable trays.

   8) UPS equipment

b. Provide 1/4-inch minimum height letters on the following equipment:

   1) Disconnects and starters for motors on fixed appliances and starters in MCCs

   2) Motor controllers and VFDs.

   3) Enclosed switches and circuit breakers

   4) Low voltage transformers

   5) Feeder circuit breakers in switchboards, switchgear, and distribution panelboards. Circuit breakers shall be labeled with destination panel name or load.

   6) Duplex receptacles (self-adhesive labels indicating panel and circuit number)

   7) Local control panels

   8) Raceways and junction boxes

   9) Instrumentation Labels

c. Refer to table and descriptions in subparagraphs below for acceptable labeling procedure:

Section	Title	Label Types														
		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
26 05 26	Grounding			⅝		X										
26 05 23	Control/Signal Transmission Media	X	X												X	
26 05 19	600-Volt or Less Wire and Cable	X	X			X									X	
26 05 13	Medium-Voltage Cables						X								X	
26 05 33	Raceways and Boxes															X
26 05 43	Underground Ducts and Manholes						X		X	X	X	X			X	
26 27 16	Cabinets and Enclosures			⅜												
26 05 36	Cable Trays			⅜							X	X				
26 27 26	Wiring Devices				¼											
no section	Electrical Power Monitoring and Control			⅜												
26 32 29	Rotary 400 HZ Converters			½							X					
26 32 13	Engine Generators			⅝							X					
26 33 53	Static Uninterruptible Power Supplies			⅝							X					
26 29 23	Variable Frequency Controllers			⅝							X					
26 12 00	Medium-Voltage Transformers			⅝							X		X			
26 35 33	Low-Voltage Power Factor Correction Capacitors			⅜	X								X			
26 13 00	Medium-Voltage Load Interrupter Switchgear			⅝							X		X			
26 13 26	Medium-Voltage Metal-Clad Drawout Circuit Breaker Switchgear			⅝							X		X			
26 18 39	Medium-Voltage Motor Controllers			⅝							X		X			
26 13 19	Medium-Voltage Pad-Mounted Vacuum Interrupter Switchgear			⅝							X		X			
26 11 16	Secondary Unit Substations			⅝												
26 28 16	Enclosed Switches and Circuit Breakers			⅝												
26 36 00	Transfer Switches			⅝												
26 23 00	Low-Voltage Switchgear			⅝												
26 24 13	Low-Voltage Switchboards			⅝												
26 09 26	Panelboards			½												
26 24 19	Motor-Control Centers			⅝												
26 29 13	Motor Controllers			⅜												
26 25 00	Low-Voltage Busway			⅜								X	X			

Section	Title	Label Types														
26 22 00	Dry-Type Transformers (600-Volt and Less)			½												
26 28 13	Fuses				X											
26 43 13	Transient Voltage Suppression			⅜												
26 51 00	Interior Lighting				X											
26 56 00	Exterior Lighting															
26 09 23	Lighting Controls			½												
28 31 00	Fire Alarm			½												
26 08 00	Acceptance Testing												X			

B. Heat-shrink preprinted tubes, flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200-degree F. Comply with UL 224.

C. Preprinted, flexible, self-adhesive vinyl label laminated with a clear weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Engraved melamine plastic laminate flat stock, 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 15 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise. UV-inhibited when used outdoors. Secure with stainless steel drive screws, stainless steel self-tapping screws or stainless-steel oval-head 6-32 screws tapped into enclosure, or with stainless steel bolts with elastic stopnut.

E. Adhesive-backed plastic machine-printed labels, white with black letters. Indicate panel name and circuit number(s).

1. For Raceway at more than 600V, provide black letters on an orange field label with the legend, “HIGH VOLTAGE”. Indicate feeder number.

F. Plain-colored vinyl adhesive tape, 3-mil minimum by 1-inch-wide minimum. Apply 1/2-inch minimum over-wrap through 2-inch minimum length. Refer to Section 26 05 19 – Low-Voltage Conductors, Wires and Cables for color.

G. Engraved plastic melamine laminate flat stock. 1/16-inch minimum thickness for sizes up to and including 15 square inches, 1/8” thick for larger than 15 square inches. White background with black letters for normal power, red background with white letters for emergency power. Holes at each end for attachment with nylon ty-wraps.

H. Underground line warning tape with pre-printed warning message identifying type of system. Material shall be pigmented polyolefin, continuous-printed on one side, and

compounded for unlimited life when direct buried. 6-inch minimum width by 4-mils thick. Tensile strength of 1750 psi.

1. Inscriptions for Red-Colored Tapes: ELECTRICAL LINE, HIGH VOLTAGE.

2. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATION CABLE, OPTICAL FIBER CABLE.

I. Underground metallic line-warning tape with pre-printed warning message identifying type of system. Material shall be detectable three-layer laminate consisting of printed pigmented polyolefin, a solid aluminum-foil core with a clear protective film that allows inspection of the continuity of the conductive core, and compounded for unlimited life when direct buried. Use when metal-detection of line is required on Medium Voltage Systems. 6-inch minimum width by 4-mils thick.

1. Inscriptions for Red-Colored Tapes: "CAUTION: MEDIUM VOLTAGE ELECTRICAL LINE BELOW".

J. Warning signs: Baked Enamel on aluminum plate, punched or drilled for fasteners, with colors, legend, and size required for applications. ¼-inch grommets in corners for mounting. Minimum nominal size of 7 by 10 inches with 0.040-inch minimum thickness. OSHA standard wording where approved. Custom wording if required. Secure with non-corrosive fasteners.

1. Where applicable, provide labels for multiple power source warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"

K. Warning labels: Self-adhesive, multicolor, flexible pressure-sensitive vinyl conforming to OSHA "Danger" and "Caution" standards. 2½ x1¾" minimum with black letters on yellow background. Label shall read: "WARNING! DO NOT USE AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL - CABLES ADDED AFTER INITIAL INSTALLATION REQUIRE POS/F & I APPROVAL."

1. Where applicable, provide labels for multiple power source warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES"

L. Stencils: Machine-punched patterns, nonfading waterproof paint with color and formulation appropriate for material and location. Minimum letter height shall be 1 inch.

M. Adhesive-backed metal labels manufactured with testing agency logo. Punched or engraved with actual settings and date. Label shall be 1/16-inch minimum thickness for sizes up to 15 square inches. Use 1/8-inch minimum for sizes larger than 20 square inches. Black with white letters for normal power systems and red with white letters for emergency power systems, with height as shown in table above unless specified otherwise.

N. Stainless-steel machine or hand-stamped wire marker plates with one hole at each end for attachment with non-corrosive fasteners that do 0.010-inch minimum thickness (for outdoor application).

O. Adhesive machine-printed plastic tape, cut to length, black with white letters unless specified otherwise. 3/8-inch minimum width of tape in unfinished areas only. Provide white lettering on red background when served by an emergency source.

2.2 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Floor Marking: Coordinate with the Port Electric Shop for painting working clearances on the floor in front of the equipment.

B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior and interior).

PART 3 EXECUTION

3.1 INSTALLATION

A. Fasteners for labels and signs: Self tapping, blunt-ended stainless-steel screws, or stainless-steel machine screws with nuts and flat and lock washers. Sheet metal screws are not acceptable. Self-drilling screws are not allowed.

B. Install identification labels according to manufacturer's written instructions.

C. Install labels where indicated and as required by the Authority Having Jurisdiction and the Department of Labor and Industries. Locate for optimum viewing and without interference with the operation and maintenance of equipment.

D. Verify identity of each item before installing identification products.

E. Labeling abbreviations not permitted without F&I approval.

F. Temporary markings allowed only if removable without damage to equipment or enclosure finish.

G. System Identification Color-Coding Bands for Raceways: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

1. 208/120V Blue

2. 480/277V Yellow
3. Controls Black

H. Cable Ties: For attaching tags. Use general-purpose type, fungus inert, self-extinguishing, one-piece, self-locking Type 6/6 nylon, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In spaces handling environmental air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Coordinate names, abbreviations, colors, graphics and other designations used for electrical identification with corresponding designations used in the Contract Documents or as required by codes and standards. Use consistent designations throughout the Project. Labeling abbreviations are not allowed.

K. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish Work.

1. Coordinate installing electrical identifying labels prior to installing acoustical ceilings and similar finishes that conceal such items.

L. Clean surfaces of dust, loose material, and oily films before applying painted or self-adhesive identification products.

M. Painted Identification Products:

1. Prime surfaces according to manufacturer's instructions prior to applying painted labels:

a. For galvanized metal, use single-component, acrylic vehicle coating formulated for galvanized surfaces.

b. For concrete masonry units, use heavy-duty, acrylic-resin block filler.

c. For concrete surfaces, use clear, alkali-resistant, alkyd binder-type sealer.

2. Apply one intermediate and one finish coat of paint.

3.2 IDENTIFICATION SCHEDULE

A. Panelboard Schedules:

1. Panelboard schedules shall utilize a standard panel schedule in Microsoft Excel format which has provision for totaling all loads and performing demand calculations by load category.

2. This schedule shall be updated with as-built information upon the completion of the project. The contractor shall post a hard copy of the revised panel schedule in any panel modified and submit an electronic copy of the panel schedule in excel format showing accurate as-built information.

3. Panelboard schedules shall be type-written and printed with a finalized laminated copy placed interior to the panel. Schedule shall be placed in manufacturer door mounted sleeve or affixed to the inner door with adhesive tape.

B. Instrumentation Labels: Affix permanent type nameplate or tag on all field-mounted instruments, transmitters, pressure gauges, and control valves with proper identification number and service description.

1. Provide 3”x1” aluminum or stainless-steel tag stamped with the instrument loop number designation and the calibrated range.

C. Medium Voltage Raceways: Provide 5/8-inch-high stenciled or manufactured letters noting “HIGH VOLTAGE”, black letters on yellow background on all exposed feeder conduits where entering or leaving switchboards and along conduit runs at 25 feet on center.

D. Accessible Raceways, More Than 600 V: Self-adhesive vinyl labels. Install labels at all conduit penetrations and along length of exposed conduit run at 25-foot maximum intervals.

E. Accessible Raceways within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.

1. Provide labels on all raceways, junction and pull boxes indicating panel designation and circuit number for all circuits in raceway or box, and conduit destination.

a. Conduit Label Example: B2-P4-23G-1/1,3,5, B-2601-9.

b. Provide labels at all locations where conduit penetrates walls, floors and ceilings, on both sides of penetration.

c. Provide labels at all ends or breaks in conduit runs such as electrical rooms, junction boxes, pull boxes, cabinets, maintenance holes, fire penetrations, etc.

d. Provide labels on each conduit entering junction or pull box within 12” of junction or pull box.

e. Provide labels at 25-foot maximum intervals along conduit runs.

f. Provide labels on all junction and pullboxes, including in accessible ceiling spaces and exposed in unfinished areas. Refer to specification sections for identification requirements for systems contained within.

g. Install labels parallel to equipment lines.

h. Labels in unfinished locations, including in accessible ceiling spaces and exposed unfinished areas shall be machine printed vinyl labels minimum ½ inch high, white with black letters. Labels in finished locations shall be adhesive-backed plastic machine printed labels, minimum 3/8-inch-high, white with black letters.

i. Lettering shall be a minimum of ¼" high.

j. In finished locations, provide labels on inside of junction or pull box cover.

k. Provide red lettering when served by an emergency source.

F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for feeder and branch-circuit conductors.

a. Provide colored insulation when available, typically for wire sized #8 AWG and smaller.

b. Provide minimum 2-inch-wide band of colored plastic tape at all terminations and splices (where allowed). 3M Scotch No. 35, Or Approved Equal Electrical Color Coding Tape.

c. Colors for 480/277V 3Ø, 4-wire systems:

1) Phase A (left or top):	Brown.
2) Phase B (center):	Orange.
3) Phase C (right or bottom):	Yellow.
4) Neutral:	Gray.
5) Ground:	Green.

d. Colors for 208/120V, 3Ø, 4-wire systems:

1) Phase A (left or top):	Black.
2) Phase B (center):	Red.

3) Phase C (right or bottom): Blue.
4) Neutral: White.
5) Ground: Green.
6) Isolated Ground: Green with yellow or orange stripe.

e. 575V, 3Ø, 4-wire systems:

1) Phase A (left or top): Brown with purple stripe.
2) Phase B (center): Orange with purple stripe.
3) Phase C (right or bottom): Yellow with purple stripe.
4) Neutral: Gray with purple stripe.
5) Ground: Green.

f. Colors for 120/240V, 1Ø, 3-wire systems: (non-standard)

1) Phase A: Black.
2) Phase B: Red.
3) Neutral: White.
4) Ground: Green.

g. For 240-delta systems (obsolete) the color of the high leg (approximately 200 volts to ground) shall be red. Label interior of all equipment “CAUTION: HIGH LEG IS OVER 120V TO GROUND. DO NOT USE FOR 120V CIRCUITS”.

h. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

2. Provide wire markers on each conductor in panelboards, gutters, pull boxes, outlet and junction boxes and at the load connection. Identify with branch circuit or feeder number for power and lighting circuits.

a. Install conductor labeling in panelboards and enclosures to ensure labels are visible.

G. Power-Circuit Conductor Identification, Medium Voltage: Provide labeling at all accessible locations including each termination or interconnection of wiring, and in vaults, pull and junction boxes, manholes, and handholes. Identify conductors with cloth type, split sleeve or tubing type wire and cable markers.

1. Label each cable with phase designation, operating voltage and circuit number.

2. Color Coding for Phase:

a. 4160Y/2400V AC 3Ø, 4-wire:

1) Phase A: Black/Pink.
2) Phase B: Red/Pink.
3) Phase C: Blue/Pink.
4) Neutral: White/Pink.

b. 4160V Delta AC, 3Ø, 4-wire:

1) Phase A: Black/Brown.
2) Phase B: Red/Brown.
3) Phase C: Blue/Brown.

c. 12,470V Delta AC, 3Ø, 4-wire:

1) Phase A: Black/Orange.
2) Phase B: Red/Orange.
3) Phase C: Blue/Orange.

3. Provide write-on tags or nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

H. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.

1. Provide wire markers on each conductor in wire gutters, pull boxes, outlet and junction boxes and at the equipment connection. Identify with control wire number as indicated on schematics and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

J. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes with the conductor designation.

K. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

L. Conductor Identification:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.

3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

M. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

N. Workspace Indication: Install floor marking tape or paint to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

O. Warning, Caution, and Instruction Signs:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Provide OSHA standard text where approved. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location. Mount permanently in an appropriate location. Comply with ANSI A13.1 standard color and design.

2. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

3. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

P. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of

text with 1/4-inch-high lettering on 1-inch-high label. Use white lettering on black field. Apply labels parallel to equipment lines.

Q. Outdoor Equipment: Engraved, laminated acrylic or melamine label, to comply with requirements listed above. Provide panel schedule printed on 8.5x11 paper in Port standard format in each panelboard. Insert folded schedule in schedule holder on inside of panel door. Posted panel schedule shall be updated to reflect all new work in panel. Include project completion date on schedule.

R. Provide self-adhesive tape labels on all receptacle cover plates. Labels shall be machine printed with black lettering on white or clear background.

1. Indicate source panel name and circuit number.

2. Provide red lettering on white or clear background for devices on emergency circuits.

3. Where receptacle faceplate is dark color, provide white letters on clear background.

END OF SECTION

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SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution

1.2 SCOPE

A. This section specifies the preparation of a Power System Study Report using PowerTools SKM, etap, EasyPower or similar software. The report shall include arc flash analysis, short circuit and coordination studies for all voltage levels of the electrical power system. The "electrical power system" starts at and includes the utility feed. Refer to the single-line diagrams of this Contract for details of the electrical power system at the Site. Provide in the report an evaluation of the electrical power system and the model numbers and settings of the protective devices for the entire system. Arc flash analysis shall include the method and recommendation in determining proper Personal Protective Equipment (PPE) and proper labeling of equipment as specified in this section. Provide equipment arc flash warning labeling.

B. Arc-flash hazard studies shall include all new and modified equipment in the power distribution system including but not limited to:

1. Utility equipment.

2. Switchgear.

3. Switchboards.

4. Generators.

5. Transformers:

    a. Including all dry-type transformers.

6. Motor Control Centers.

7. Free standing variable frequency drives and starters.

8. Disconnect Switches.

9. Motors.

10. Panelboards:

    a. Including all 208, 240, and 480-volt systems.

11. Vendor Control Panels.

12. HVAC Equipment.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NFPA 70E	National Electrical Safety Code
IEEE 1015	Recommended Practice for applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
IEEE 902	Guide for Maintenance, Operation and Safety of Industrial and Commercial Power Systems
NFPA 70	National Electrical Code
IEEE 1584	IEEE Guide for Performing Arc-Flash Hazard Calculations
ANSI NETA ATS 2021	Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. QUALIFICATIONS:

1. Prepared by the manufacturer of the electrical equipment or by an electrical testing service or an engineering company which is regularly engaged in power system studies.

2. All calculations shall be prepared by or prepared under direct supervision of a Oregon State registered Professional Electrical Engineer. See the General Conditions for insurance requirements.

C. CERTIFICATION: Arc flash report to be stamped and signed by a Oregon State registered Professional Electrical Engineer.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Qualifications of the entity conducting the short circuit and coordination study.

4. Short Circuit Analysis and recommended breaker and relay setting selections in coordination with Section 26 08 00.

5. Electronic copies of power study software models with associated electronic library files.

6. Submit a draft report to the owner within 21 days after receiving all electrical distribution system submittal data and feeder lengths. Approval of submittals shall be contingent on the results of the Power System Study Report.

7. SCOPE OF EQUIPMENT: Contractor shall provide a short circuit and protective device coordination study and arc flash analysis for phase and ground faults for the entire electrical distribution system. The study and labeling conforms to NFPA 70E and the National Electrical Code.

PART 2 PRODUCTS

2.1 POWER SYSTEM STUDY REPORT

A. Prepare a Power System Study Report summarizing the short circuit and coordination study, arc flash analysis and conclusions or recommendations which may affect the integrity of the electric power distribution system. The model and report shall reflect the project naming convention.

B. As a minimum, include the following in the report:

1. Equipment manufacturer's information used to prepare the study.

2. Assumptions made during the study.

3. Short circuit calculations listing short circuit levels at each bus.

4. Evaluation of the electrical power system and the model numbers and settings of the protective devices associated with the system.

5. Time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.

6. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment connected to that bus.

7. Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels.

8. Summarize the arc flash study and conclusions or recommendations which may affect the integrity of the electric power distribution system.

9. ONE-LINE DIAGRAMS:

   a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.

   b. Type designation, current rating, range or adjustment manufacturer's style and catalog transformers.

   c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.

   d. Nameplate ratings of all motors and generator with their subtransient reactances.

   e. Transient reactances of generator and synchronous reactances of generator.

   f. Sources of short circuit elements such as utility ties, generators, and induction motors.

   g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.

   h. Standby as well as normal switching conditions.

   i. Calculated 3-phase and single-line-ground fault currents at each bus.

   j. Calculated X/R ratio at each bus.

   k. Calculated incident energy level at each bus.

   l. Hazard Risk Category at each bus.

2.2 SHORT CIRCUIT STUDY

A. As a minimum, include the following:

1. CALCULATIONS:

   a. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.

   b. Calculate the maximum and minimum ground-fault currents.

c. Model variable frequency drives and Solid-State-Soft Starters and include by-pass switches.

d. Where the calculated available fault current is higher than the device ratings determine if a Series-rated system exists. Where series-rated systems have been identified provide labeling per NEC Article 110.22.

e. Provide labeling at each service and separately derived system indicating calculated available fault current per NEC Article 110.24.

f. A copy of the SKM or EasyPower "Device Evaluation Comprehensive Branch Report". Generate report after an "Equipment Evaluation" analysis has performed using the following settings:

1) Study Result: Balanced
2) Device Type: Protective Devices
3) Fault Type: Bus
4) Fault Study: Comprehensive

2.3 COORDINATION STUDY

A. As a minimum, include a 17"x11" drawing which includes protective device coordination analysis (TCC) and associated single line. The TCC shall be shown on a 5-cycle, log-log graph background and include:

1. Time-current curve for each circuit breaker, protective relay, or fuse showing graphically that the settings will allow protection and selectively within Industry standards. Identify each curve and specify the tap and time dial setting. Any circuit protective device that has programmable characteristics shall be included in the coordination study.

2. Time-current curves for each device to be positioned for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, notify the Engineer and Owner as to the cause.

3. Time-current curves and points for cable and equipment damage.

4. Circuit interrupting device operating and interrupting times.

5. Indicate maximum fault values on the graph.

2.4 ARC FLASH ANALYSIS

A. As a minimum, include the following:

1. CALCULATIONS:

a. For each major part of the electrical power system, determine the following:

1) Flash hazard protection boundary.
2) Limited approach boundary.
3) Restricted approach boundary.
4) Prohibited approach boundary.
5) Incident energy level.
6) PPE hazard/risk category.
7) Type of PPE required.

b. Produce arc flash warning labels using the existing SKM or EasyPower model template.

c. A copy of the SKM or EasyPower "Arc Flash_IEEE 1584 Report". Generate report after an "Arc Flash Evaluation" analysis has performed using the following settings:

1) Standard: IEEE 1584
2) Flash Boundary Calculation Adjustments: Use 1.2 cal/cm^2
3) ≤ 240 V: Report Calculated Values from Equations
4) Units: English
5) Distance and Boundary: in

PART 3 EXECUTION

3.1 GENERAL

A. Perform the studies using actual equipment data from the equipment and devices that are provided by the Contractor and the data from the actually installed existing equipment or protective relay devices. The Contractor is responsible to gather all field information for the short circuit and coordination studies. Where the report or study is conducted on equipment that is not installed, the short circuit report and the coordination study shall be completely redone at the Contractor's expense.

3.2 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

A. The Contractor shall implement the protective device coordination study settings on new and existing equipment as required in Section 26 08 00, based on the accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

B. The Contractor shall work with the Study Firm for implementing the Arc Flash Hazard sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION

SECTION 26 05 85 - UTILITY COORDINATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for:

1. Coordination with the Utility companies to provide service.

2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.

3. Descriptions of utility services required.

B. The Contractor shall coordinate with the local electric Utility for the installation of the primary electrical service.

1. Electric Utility:

a. Utility: Pacific Power

b. Phone number: 800-469-3981

c. Primary Contact: Douglas Triebelhorn

1) Phone number: 541-278-2957

2) Email: Triebelhor@pacificorp.com

2. Contractor shall coordinate with Pacific Power local electric utility prior to installing underground conduit. See Drawings for the separation point between the local electric utility and the Contractor.

3. Temporary power is not currently available to the project site. Contractor shall coordinate and provide temporary power at the project site when required and necessary.

1.2 REFERENCES

A. Refer to Section 26 05 00.

1.3 DEFINITIONS

A. Refer to Section 26 05 00.

1.4 SYSTEM DESCRIPTION

A. Electrical Service:

1. Provide electrical ducts, raceways, conductors, and connections indicated on the Drawings. Work and materials required for a complete electrical service shall include but not be limited to the following:

a. Electrical service conduits from the point of Electric Utility connection to the service entrance equipment.

b. Metering conduits and conductors from the instrument transformers to the meters.

B. General:

1. Coordinate and obtain inspections and final installation approval from serving utilities and other authorities having jurisdiction.

1.5 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 and 26 05 00.

B. Certification:

1. Submit certification that the intended installation has been coordinated with the Utility companies.

2. Certification shall include a narrative description of the Utility's requirements and points of connection and names and telephone numbers for contacts at the Utilities.

1.6 QUALITY ASSURANCE

A. Refer to Section 26 05 00.

B. Materials and equipment used in performance of electrical work shall be listed or labeled by Underwriter's Laboratories or other equivalent recognized independent testing laboratory.

1.7 PROJECT OR SITE CONDITIONS

A. Refer to Section 26 05 00.

1.8 SCHEDULING

A. General:

1. Before start of site work, make arrangements for temporary electrical service as required.

B. Electrical systems:

1. Before bidding, the Electrical Contractor shall contact the Utilities to determine the work and materials provided by Pacific Power and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.

2. Before commencing work, coordinate electric service entrance requirements with local Electric Utility to assure that the installation is completed in accordance with these Specifications:

a. Ensure electrical characteristics and location are consistent with the design.
b. Arrange for installation of utility meter.

3. Coordinate with the Electric Utility for connection and turn-on.

C. Before commencing site work, coordinate underground conduit installations with other work to eliminate conflicts and avoid interferences with other underground systems.

1.9 WARRANTY

A. Refer to Section 26 05 00.

1.10 COMMISSIONING OF ELECTRICAL SYSTEMS

A. Refer to Section 26 08 00.

PART 2 PRODUCTS

2.1 MATERIALS

A. Furnish materials in accordance with the applicable requirements of the utilities and these Specifications.

2.2 EQUIPMENT

A. Furnish equipment in accordance with the applicable requirements of the Utilities and these Specifications.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation of service equipment to be in coordination with utility requirements

B. Refer to Section 26 05 00.

END OF SECTION

SECTION 26 05 86 - PREMIUM EFFICIENCY VERTICAL MOTORS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

Work consists of all motors shown on the drawings and specified herein and in other divisions of the specifications. In general, all motors shall be premium efficiency and furnished with the driven equipment. The requirements of all other sections of the specifications are equally applicable to the work to be performed under this section. Motors and controls are specified in this and other divisions of the specifications. In the event of conflicts, the more restrictive specifications shall apply.

1.2 SUBMITTALS

Complete motor data shall be submitted and include the following data:

A. Motor manufacturer.
B. Motor type or model and dimension drawing to include motor weight.
C. Nominal Horsepower.
D. NEMA Design.
E. Enclosure.
F. Frame size.
G. Winding insulation class and treatment.
H. Rated ambient temperature.
I. Service factor.
J. Voltage, phase, and frequency ratings.
K. Full load current at rated horsepower for application voltage.
L. Starting code letter, or locked KVA, or current.
M. Special winding configuration.
N. Rated full load speed.
O. Guaranteed minimum Power Factor at 100, 75 and 50 percent of full load.
P. Guaranteed minimum efficiencies at 100, 75 and 50 percent of full load.
Q. Starting torque.
R. Full load torque.
S. Breakdown torque.
T. Rated temperature rise at rated horsepower.
U. Full load current at rated voltage.
V. Current at no load on shaft at rated voltage.
W. Connection diagram.
X. RTD – Resistance Temperature Detector: 100 ohm Platinum.
Y. Superimposed load speed torque curve over motor speed torque curve.
Z. Recommended spare parts list priced.

PART 2 PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and built for industrial service and be capable of operating successfully under the following applicable conditions.

1. 40 degrees C maximum ambient temperature.

2. Voltage variations to + 10% of nameplate rating.

3. Frequency variations to + 5% of nameplate rating.

4. Combined voltage and frequency variations to + 10% total, as long as frequency does not exceed + 5%.

5. 3,300-foot maximum altitude.

2.2 ELECTRIC MOTORS

A. General: Electric motor driven pumps shall be premium efficiency with vertical hollow shaft electric motors, design B, high thrust, squirrel cage, induction type having NEMA weather protected type WP1 enclosures unless otherwise specified. Motors shall be suitable electrically and mechanically to efficiently and effectively drive pumps. Motors shall operate in accordance with these specifications. Motors shall be sized such that the pump BHP shall not exceed the nameplate data at any location on the full-speed operating curve.

B. Unless specified otherwise, all materials, workmanship and tests shall conform with the applicable specifications to NEMA, IEEE, ASA and AFBMA.

C. Motor frame shall be steel or cast iron, aluminum shall not be permitted.

D. Motors shall be rated for operation at 460 VAC, 3 phase, 60 hertz, Service factor of 1.15 or greater. Motors shall provide the minimum horsepower at the maximum rpm stated in Section 43 21 27, Vertical Turbine Pumps, Can Type, Open Lineshaft.

E. Motors shall be rated for premium efficiency. Rated efficiencies shall be based on NEMA standards MG1-12.536 or standards imposed by the local electric utility, whichever is more restrictive.

F. Motors shall be capable of full load operation with voltage variations of +/- 10% and frequency variation of +/- 5%.

G. Motor starting current shall not exceed 650% of motor full load current.

H. Insulation system: All motors shall be provided with Class “F” or better insulation systems except that motor lead insulation may be class “B” or better. Completed windings, when tested in accordance with IEEE #57 shall show a thermal rating not less than 150 degrees for 30,000 hours of life.

I. Windings shall be held firmly in stator slots to prevent coil shift. Stator windings shall be of high conductivity copper magnet wire. Completed stator windings shall be provided with a properly cured, uniform impregnation for mechanical rigidity, moisture resistance, and protection against winding failure from accumulation of foreign conductive matter. The completed insulation system shall be capable of withstanding phase to ground rms voltage of 600 volts continuous and 2,300 volts instantaneous.

J. All motors used with variable frequency drives shall be inverter duty, have a minimum of 1600 volt insulation on the windings, have insulated motor bearings and shaft grounding rings and shall be compatible with the VFD specified elsewhere in Division 26.

K. Rated temperature rise above 40 degrees C ambient temperature, at service factor load of 1.15 shall not exceed 90 degrees C.

L. Motors rated 50 Hp and larger shall be rated NEMA locked rotor Code G or better.

M. Motors shall be dynamically balanced to a maximum of .001 inches peak to peak amplitude.

N. Motors shall be equipped with anti-friction type thrust and guide bearings. Angular contact thrust bearings shall be used. Bearings shall be of sufficient capacity to withstand all static and dynamic thrust loads, both momentary and continuous, imposed by the pump. Bearings shall provide minimum 3-year life based on continuous design thrust loads. For variable frequency applications, bearings shall be insulated and shaft shall be grounded with a shaft-grounding/bearing protection ring.

O. Motor thrust bearings shall be lubricated with the lubrication system recommended by the manufacturer to provide optimum lubrication of bearings for long life and trouble free operation. Motors lubricated with oil shall have visual level indicators and accessible fill and drain plugs for the oil reservoir.

P. Motors shall be equipped with non-reverse mechanisms which shall limit maximum reversal to 10 degrees of rotation.

Q. Motors shall be equipped with fabricated steel conduit boxes. The box shall be sized for conduits and conductor size shown on the plan drawings and cable or conduit schedule with stress cone terminations for main motor leads. Separate accessory terminal boxes shall be provided for space heater and temperature sensors.

R. Motor Nameplates shall include Manufacturer name, serial number, rated horsepower, service factor, frequency, phase, load voltage, full load amps, full load speed, design designation, locked rotor current and or designation, insulation class, temperature rise, maximum ambient temperature, NEMA efficiency, and full load power factor, time rating, model #, bearing identification, frame size, thermal protection, nominal and guaranteed efficiency.

S. Coating System: Manufacturers standard corrosion resistant coating.

T. Motors shall be as manufactured by General Electric Company, or US Motors.

PART 3 EXECUTION

3.1 GENERAL

Install equipment and materials in a neat and workmanlike manner and align, level and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance, and repair.

3.2 WIRING

Arrange wiring in cabinets, panels and motor control centers neatly cut to proper length and remove surplus wire. Apply stack-on or similar terminals to control wiring for connection to terminals, and bridle and secure in an approved manner. List all circuits emanating from power, distribution, and lighting panelboards by function on the directory card. Identify all circuits entering motor control centers or other control cabinets by directory card listing terminal block number and function or by means of tags securely fastened to the conductors.

END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Testing.
7. Functional Checkout.

1.2 SCOPE

A. This section specifies the acceptance testing of electrical materials, equipment, and systems. Provide all labor, tools, material, power, and other services necessary to provide the specified tests. All testing described in this section shall be coordinated with the requirements of Section 01 75 16.

B. All testing required herein and the test results shall also be submitted and documented as required under Sections 01 75 16, 26 05 00, and where identified within the specific sections.

C. Test results for a specific piece of equipment shall also be included in the operation and maintenance manual(s).

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or other- wise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI/NETA ATS- 2021	Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

C. APPLICATION: Where testing in accordance with this section and other Division 26 Sections is required or recommended by the above standards are to be completed prior to energization, the required tests, including the retesting after the correction of found defects must be complete, and the submittal of final test reports to the Owner for review shall be completed prior to the energizing of material, equipment, or systems.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. Comply with section 5, General, of the ANSI/NETA ATS – 2021 standard for safety, test equipment requirements.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Proposed testing procedures including proposed test report forms.

2. Test reports including documentation for all tests performed. Test reports shall be submitted for review prior to the equipment being energized.

3. Execution plan including schedule.

PART 2 PRODUCTS

2.1 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

2.2 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00 and Section 01 75 16:

1. Test reports: Provide the report required in NETA ATS-2021 paragraph 5.4. Results shall be placed on the forms specified in this Section. Test reports shall also be part of the operation and maintenance manuals.

    a. The test report shall include the following:

        1) Summary of project.

        2) Description of equipment tested.

        3) Description of tests.

        4) Device settings.

        5) Test data.

    b. Test data records shall include the following

        1) Equipment Identification.

        2) Nameplate data.

        3) Date of testing.

        4) Expected test value/result.

        5) Actual test result.

        6) Testing results outside of acceptable limits.

2. Short circuit analysis and protective device curves.

3. Defects: Notify the Owner of any material or workmanship found defective within 24 hours of discovery.

PART 3 EXECUTION

3.1 TESTING

A. GENERAL

1. Ensure that all testing performed is in strict conformance with the electrical acceptance tests specified herein. Contact the Owner 10 days prior to the testing to allow witnessing of all tests.

2. The test measurements shall be recorded on specific forms for the subject test.

3. Testing shall be per ANSI/NETA ATS 2021. Provide testing data sheet for the following:

    a. Switchboard assemblies.

    b. Transformers – Small Dry-type, air cooled (600 VAC and below, 30 kVA and larger)

    c. Cables – Low voltage (600 VAC maximum)

    d. Circuit breakers – Low voltage (Insulated Case/Molded Case)

    e. Protective Relays

    f. Instrument Transformers

    g. Metering and Monitoring Equipment

    h. Grounding Systems

    i. Ground Fault Protection Systems

    j. Rotating Machinery

    k. Motor Control

    l. Variable Speed Drive Systems

    m. Outdoor Generator Systems

    n. Uninterruptable Power Systems

    o. Manual and Automatic Transfer Switches

B. FUNCTIONAL CHECKOUT:

1. Comply with all requirements of 26 05 00 and 01 77 00

2. Functional testing shall be performed in accordance with the requirements of this Section. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energizing the equipment, perform a functional checkout of the control circuits. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Submit a description of proposed functional test procedures prior to the performance of functional checkout.

3. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor after confirming that neither the motor nor the driven equipment will be damaged by reverse operation.

END OF SECTION

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SECTION 26 22 13 - LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Products
6. Execution

1.2 SCOPE

A. This section covers the work necessary to furnish and install low voltage transformers.

B. The following supplements all sections of this specification and applies to all work specified, shown on the drawings, or required to provide a complete installation of approved electrical systems.

C. The Contractor shall furnish and install single-phase or three-phase general purpose individually mounted dry-type transformers, self-cooled as specified herein, and as shown on the contract drawings.

D. System Characteristics

1. 480/277 VAC 3 PHASE 4 WIRE: 120/208 VAC 3 PHASE 4 WIRE
2. 480 VAC 1 PHASE: 120/240 VAC 1 PHASE
3. 120 VAC 1 PHASE: 24 VDC

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

C. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NFPA 70	National Electrical Code
NFPA 70E	National Electrical Safety Code
UL 50	
UL 67	Underwriters Laboratories
NEMA	TP-1

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment first start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

4. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

5. Transformer Ratings including:

a. KVA rating
b. Primary & Secondary Voltage
c. Taps
d. Design Impedance
e. Insulation class
f. Sound level

1.6 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURES/PRODUCTS

A. Candidate manufacturers and models are listed below. To conform to specified requirements, the manufacturer's standard product may require modification.

1. Eaton
2. Schneider Electric / Square D
3. GE
4. Approved Equal

2.2 DRY TYPE TRANSFORMERS

A. General: Provide all power transformer equipment as shown on the drawings in conformance with the following specification. All transformers shall be built in accordance with the latest revised IEEE, ANSI, and NEMA standards. All transformers shall conform to NEMA TP-1 standards.

B. Temperature Ratings: On all transformers, case temperature shall not exceed 30 degrees Centigrade rise above an ambient temperature of 40 degrees Centigrade. Terminal compartment shall be located to ensure termination of cable leads in temperature levels not to exceed 75 degrees Centigrade. Transformers shall be designed for full load operation at a maximum temperature rise of 115 degrees C.

C. Size: Voltage and KVA rating shall be as shown on the drawings. Provide continuous overload capability of 15%. Primary voltage windings shall have a BIL rating of 10 kV.

D. Enclosure: For general application, enclosures shall be drip-proof and rodent-proof. Ventilating openings shall be louvered; screening will not be acceptable. Design shall incorporate a built-in vibration dampening system. Finish shall be ANSI 60. Conform to the limited access requirements where applicable.

E. Core and Coil Assemblies: Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer

operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.

F. Taps: Furnish a minimum of four taps, two above and two below rated voltage, each 2-1/2 percent, for ratings above five (5) kVA.

G. Tests: Provide routine tests as listed and described in ANSI specification No. C57.12.00, latest edition. Sound level tests shall be performed on the complete transformer assembly in accordance with the latest NEMA standards. Transformer 0-75 kVA shall conform to NEMA standards.

PART 3 EXECUTION

3.1 EQUIPMENT BASES

A. Provide equipment bases for all floor-mounted electrical equipment. Unless otherwise indicated, bases shall be poured-in-place concrete, nominally four inches high, and be one inch larger on all exposed edges than the equipment to be mounted. Bolt equipment to pad. Provide concrete pads and mounting provisions for all exterior equipment as indicated on the drawings or specified in other portions of the specifications.

3.2 SUPPORTS

A. Provide equipment bases for all floor-mounted electrical equipment. Unless otherwise indicated, bases shall be poured-in-place concrete, nominally four inches high, and be one inch larger on all exposed edges than the equipment to be mounted. Bolt equipment to pad. Provide concrete pads and mounting provisions for all exterior equipment as indicated on the drawings or specified in other portions of the specifications.

B. Provide Uni-strut or similar supports and backing for wall mounted equipment where structure is suited for such mounting.

3.3 DAMP AND WET LOCATIONS

A. Unless otherwise specified, all electrical enclosures in damp and wet locations shall be NEMA 4, stainless steel.

B. All conduit entries into equipment located in damp or wet locations shall be through the bottom or lower sides of enclosures. Top entry of conduits will not be allowed.

3.4 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.5 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 77 00 - Project Closeout 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

3.6 TESTING

A. Service Equipment shall be tested for proper operation and function in accordance with Section 26 08 00.

END OF SECTION

SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Products
6. Execution

1.2 SCOPE

A. Motor Control Centers as specified and as shown on the contract drawings shall be furnished and installed by the Contractor.

B. The drawings are the basis for required programming within the MCC for manual operation of the motor starters. The manufacturer or its designated field service group shall program, test, commission and certify operation of the MCC equipment.

1.3 REFERENCE STANDARDS

A. The Motor Control Center shall be manufactured and tested according to the latest applicable standards of the following agencies:

1. UL 845 – Motor Control Centers

2. NEMA ICS 18-2001 – Motor Control Centers

3. NEMA ICS 1-2001 – Industrial Control and Systems: General Requirements

4. NEMA ICS 2.3-2008 – Industrial Control and Systems: Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers

1.4 QUALITY ASSURANCE

A. REQUIREMENTS:

1. Section 26 05 00 General Requirements for Electrical Work.
2. Section 26 29 23 Low Voltage Adjustable Frequency Drives
3. Section 26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Arrangements and dimensions shown on the drawings are provided to show intent. Contractor and equipment supplier are to verify installation requirements and ensure the arrangement of the equipment being submitted will suit the intent of the design and is compatible with the installation requirements.

   Where the proposed arrangement differs from the intent shown on the drawings, the contractor is to make note of the variance and offer an explanation for the change.

4. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

C. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

D. Certificate of Compliance for Seismic Design of Nonstructural Components and Systems.

E. Manufacturer Seismic Qualification: The low voltage motor control center(s) shall meet and be certified to seismic requirements specified in the IBC 2018 International Building Code. Refer to Specification section 01 41 20.

1.6 QUALITY ASSURANCE

A. Manufacturer: For equipment required for the work of this section, provide products which are the responsibility of one manufacturer.

B. Manufacturer shall have had produced similar electrical equipment for a minimum of 5 years.

C. Manufacturer shall be ISO 9001 certified.

1.7 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manual. One (1) copy of this document shall be provided with the equipment at the time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the following:

1. Allen Bradley
2. ABB
3. Group Schneider/Square D
4. Approved Equal

2.2 GENERAL REQUIREMENTS

A. STRUCTURES

1. The enclosure shall be NEMA Type 12 with gasketed doors. Vertical sections shall be constructed with steel divider sheet assemblies formed or otherwise fabricated to eliminate open framework between adjacent sections or full-length bolted-on side sheet assemblies at the ends of the MCC(s).

2. Vertical sections shall be 90" high excluding mounting sills, 20" wide and 20" deep for front mounting of units.

3. Vertical structures shall be divided into six (6) 12" space factors and shall accommodate six (6) full size NEMA size 1 or 2 Full Voltage Non-Reversing FVNR combination starters. MCC unit sizes shall be multiples of 1/2 space factor (6"). The vertical structures shall accommodate 6" high density and dual mounted units.

4. Back-to-back, front and rear unit mounting, structures shall be 21" deep maximum and shall accommodate 12 full size NEMA size 1 or 2 Full Voltage Non-Reversing FVNR combination starters per section.

5. 4" wide wireways shall be installed on 20" wide structures and 8" wide wireways on 24" wide structures. Wireways shall be completely isolated from all power busses. The rear surface of the vertical wireway shall be painted white. A minimum of three (3) formed wire cable supports, extending the full depth of the vertical wireway shall be supplied in each vertical section. A separate hinged door shall cover the vertical wireway.

6. Each standard structure shall be supplied with a 12-inch top and six (6) inch bottom horizontal wireway that are continuous for the entire length of the MCC. The

minimum horizontal wireway opening between sections is 40 square inches for the top and 30 square inches for the bottom horizontal wireway. A hinged door shall be supplied to cover the top horizontal wireway.

7. Doors are to be hinged in a manner that allows for the removal of individual doors without the removal of any door above or below. Unit doors shall be hinged on the left and vertical wireway doors on the right for unobstructed access to the units and associated vertical wireway. All doors shall be mounted on removable pin-type hinges and secured with steel quarter-turn, indicating type fasteners.

8. Wireways shall be completely isolated from bus compartments by suitable barriers. Sliding barriers between the horizontal bus and top horizontal wireway are not acceptable.

9. Removable top cover plates shall be provided for conduit entry to the top horizontal wireway and shall provide a minimum of 116 square inches of area for conduit location. Top cover plates shall be fabricated from 13-gauge steel.

10. All MCC structures shall be supplied with 1-1/8" high X 3" wide base channel sills that are continuous for the entire length of the shipping split. The base channel sills shall be fabricated of 7-gauge steel and shall be suitable for grouting the base channel sills in place, welding to leveling plates or securing to the floor with 1/2" anchor bolts. MCC structures shall be supplied with reversible bottom end cover plates to cover the bottom horizontal wireway and ends of the base channel sills. The bottom end cover plates shall be factory installed to cover the ends of the base channel sills to prevent entrance of dirt and rodents into the MCC when installed flush on the floor and shall be removable to expose the ends of the base channel sills if they are to be grouted into the floor.

11. A removable, full length lifting angle shall be provided for each shipping split of each MCC. The lifting angle shall be bolted to each side sheet or divider sheet of the shipping split to evenly distribute the weight of the MCC during lifting.

12. MCC's shall be assembled in such a manner that it is not necessary to have rear accessibility to remove any internal devices or components.

B. BUSSING

1. The main horizontal bus shall be:

    a. Tin plated copper with current rating as shown on the drawings with a 600Aminimum and with a conductivity rating of 100% IACS. The horizontal bus bars shall be fully sized to carry 100% of the rated current the entire length of the MCC. Horizontal bus bars shall be mounted edge wise and located at the

top of the MCC. Tapered horizontal bus is not acceptable.] All power bus shall be braced to withstand a fault current of 65,000 RMS symmetrical amperes.

2. The vertical bus shall be:

    a. Shall be rated 300A above and below the horizontal bus for an effective rating of 600A. Vertical bus bars shall be fabricated of tin-plated solid copper bars with a conductivity rating of 100% IACS.

3. Automatic shutters shall cover plug-in stab openings when units are removed. All bus ratings are to be based on a maximum temperature rise of 65ºC over a 40ºC ambient temperature.

4. Horizontal to vertical bus and horizontal bus splice connections shall be made with two (2) 3/8" grade 5 bolts and conical washers at each connection point. All connecting hardware shall be designed to be tightened from the front of the MCC without applying any tools to the rear of the connection.

5. The horizontal ground bus shall be rated 300-amp copper.

C. UNITS

1. Plug-in units shall connect to the vertical bus by means of self-aligning, tin plated copper stab-on connectors provided with spring steel back-up springs to insure positive connection to the vertical bus.

2. When vertical ground bus is specified, plug-in units shall include a ground stab which engages the vertical ground bus before the power stabs engage the vertical bus when the unit is inserted into the structure. When the plug-in unit is withdrawn from the vertical bus, the vertical ground stab shall release after the power stabs.

3. The interior of all MCC units shall be painted white, including unit top and bottom plates or isolation barriers.

4. All plug-in units 12" tall and larger will include two (2) auxiliary handles to aid in installation, removal and transporting plug-in units.

5. All plug-in units will include a racking mechanism to assure full engagement with the stab-on connectors with the vertical bus.

6. Plug-in units shall be provided with interference mechanism type draw-out to prevent complete removal of the plug-in unit from the structure in one motion. The interference mechanism shall also provide clear indication when the plug-in unit has been withdrawn to the "TEST" position.

7. A mechanical interlock shall be supplied on all plug-in units to prevent insertion or removal of a unit from the structure when the unit operator handle is in the ON position. This interlock may not be defeated.

8. Each 12" tall and larger plug-in unit shall be secured in the structure by two (2) readily accessible devices, one of which is tool operated. These devices shall be located at the front of the unit.

9. Plug-in units with NEMA Type B or C wiring shall be supplied with unit terminal block mounted within the unit, adjacent to the vertical wireway. For non-high density units, the terminal blocks shall be mounted on a movable bracket that maintains the terminals inside the unit structure for normal operation and pivots into the vertical wireway exposing the terminals for wiring, test and maintenance.

10. All plug-in units shall include a positive means of grounding the unit to the structure at all times.

11. The MCC unit disconnect operator shall operate in a vertical, up-down, plane. 6" units shall operate in a horizontal motion. All unit disconnects shall remain engaged with the disconnect device at all times, regardless of the unit door position. The operating handles shall be interlocked with the unit door so that the door can neither be opened with the disconnect device in the ON position, nor can the disconnect device be turned ON with the unit door open except by operation of a defeater mechanism. Indication of the disconnect device shall be clearly indicated by the position of the operating handle. When applied with circuit breaker devices, the handle shall also provide clear indication of a circuit breaker trip.

12. When pilot lights, push buttons or sector switches are specified. The devices shall be mounted in a formed metal device panel that is capable of accepting four (4) such devices in any combination. The device panel shall be secured to the unit door for normal operation, or mounted on the plug-in unit as required for unit removal and bench testing.

13. Pilot devices shall be heavy duty, oil tight 30mm devices with a NEMA 4 rating. Indicating lights shall be LED push-to-test type. Pilot device contacts shall be rated at 10A, 600 VAC (NEMA A600). The pilot device bodies shall be fabricated from metal.

14. Unit identification nameplate shall be provided for each unit. Nameplates shall be a black surface with white core. Engraving shall cut through the black surface exposing white lettering of the unit designation. Nameplates shall be 1" tall by 3 1/2" wide. Adhesives or glues are not an acceptable means of mounting unit nameplates.

D. WIRING

1. The wiring shall be NEMA Class 1.
2. All internal wiring shall be labeled using heat shrink type material.

E. COMBINATION MOTOR STARTERS

1. The combination motor starters shall be provided with an Allen Bradley thermal magnetic circuit breaker unless noted otherwise on the drawings.

    a. Combination Motor Starters shall be rated equal to or greater than the AIC rating of the Motor Control Center.

2. Overload Protection

    a. The overload protection shall be:

        1) Solid state overload relay with Class 10-30 protection with manual/Auto reset.

3. Control Power

    a. Each starter unit shall be provided with an encapsulated control power transformer of sufficient size to accommodate the contactor coil burden plus all specified auxiliary devices.

F. FEEDERS

1. Feeder disconnects shall be Allen Bradley thermal-magnetic circuit breaker.

2.3 METERING

A. Multifunction digital-metering monitors shall be, microprocessor-based unit suitable for three or four wire systems. Units shall communicate via:

1. Ethernet module

B. The meter shall be mounted on the door and shall meter at the Main Lugs

C. Metering Equipment

1. Provide a multi-function, high accuracy digital power metering instrumentation module equipped with LCD display. The power metering module shall provide simultaneous measurements for current, voltage and power parameters. Power meter shall be equipped with a communications port for Industrial Ethernet connection.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation shall be per the manufacturer's recommendations, written instructions, final shop drawings, and contract documents. Installation shall be coordinated with adjacent work to ensure proper sequence of construction, clearances and support.

B. The Motor Control Center shall not be placed in hazardous locations. The location shall be well ventilated and free from humidity, dust, and dirt. The temperature shall be no less than 32°F and no greater than 104°F. Protection shall be provided to prevent moisture from entering the enclosure.

3.2 TESTING

A. Perform factory and installation tests in accordance with applicable NEMA and UL requirements.

B. Provide technically certified personnel on site to perform pre-energization tests and provide certificate of proper installation.

C. During acceptance testing, provide technical personnel onsite with capability to diagnose errors, program MCC equipment and resolve any problems within the MCC system.

D. Provide services of manufacturer's representative for testing and commission per Section 01 75 00.

3.3 TRAINING

A. Provide 4 hours of onsite training for MCC maintenance.

B. Training shall include instruction on programming equipment supplied within the MCC center including the Power Meter and VFDs.

END OF SECTION

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SECTION 26 27 13 - ELECTRICITY METERING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Product Requirements
7. Installation
8. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and installation of the Utility Metering Equipment. This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Equipment shall be mounted as shown on the plans.

1.3 REFERENCE STANDARDS

A. EUSERC Electric Utility Service Equipment Requirements Committee - metering standards and requirements

B. NETA National Electrical Testing Association.

C. NEMA National Electrical Manufacturing Association

D. NEC National Electrical Code – version in force in the area at the time of bid.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SYSTEM VOLTAGE CHARACTERISTICS

A. Provide electrical system nominal utilization voltage characteristics as follows:

Typical Voltage Description Herein	Nominal Utilization Voltage
480/277	460/265
120/208	115/200
120/240	115/230

1.6 UTILITY METERING

A. As shown on the drawings, provide a separate NEAM 3R EUSERC approved current transformer enclosure and meter base that meets Pacific Corp requirements for the amperage and voltage of the project service.

1.7 ELECTRICAL SERVICE

A. The utility company rendering electrical service to this project is Pacific Power. Furnish all labor and install all material not furnished by the utility company, including meter bases, CT cans, and transformer pads or poles as shown, or as required by utility company to render service to the project from utility service point. Verify service point metering requirements, pad construction details, service charges, etc., and include all costs in bid proposal.

B. Provide ground services as required to satisfy utility company and code requirements.

C. Provide trenching and backfill at locations shown on the plans and as required by the utility company for service cable to the project site.

D. For utility service conduit, provide sweeps per utility company standards.

E. Verify all pull boxes, transformer details, and cable details with the utility company and observe utility company standards throughout.

F. The Contractor shall pay all Power Company fees unless specified or noted otherwise.

1.8 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

F. Warranty information.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Electricity Metering Equipment candidate manufacturers and models:

1. Cutler Hammer/Eaton

2. Millbank
3. Square D
4. Approved Equal

2.2 GENERAL

A. Product Requirements: the CT enclosure and meter base shall comply with Pacific Corp standards.

2.3 FEATURES

A. Describe general operational needs

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 26 05 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.

B. Install all components of Electricity Metering Equipment in accordance with manufactures specifications and instructions.

C. Electricity Metering Equipment shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer’s recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

D. CONTRACTOR shall provide the services of the manufacturer’s representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.

E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation of the Electricity Metering Equipment so as to not be result in false reading or improper operation due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 26 05 00

B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the Electricity Metering Equipment.

END OF SECTION

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SECTION 26 27 16 - CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. This Section specifies cabinets and enclosures for electrical equipment and is intended to compliment and augment other Division 26 sections

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NECA	National Electrical Installation Standards
NEMA ICS 4	Application Guideline for Terminal Blocks.
NFPA 70	National Electrical Code (NEC)
UL 943	Ground-Fault Circuit Interrupters
UL 1010	Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. Listing and Labeling: Provide products that are Listed and Labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authority Having Jurisdiction, and marked for intended use for the location and environment in which they are installed.

C. Comply with NECA's "National Electrical Installation Standards."

D. Comply with NFPA 70, as adopted and administered by the Authority Having Jurisdiction.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

4. Manufacturer's Installation Instructions, including storage, handling, protection, examination, preparation, and installation of product.

5. Shop Drawings: Include layout drawings showing components and wiring for nonstandard enclosures, and cabinets.

6. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

1.6 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 GENERAL

A. Enclosures shall be UL approved for the application.

B. MANUFACTURER: The enclosures shall be made by:

1. Hoffmann Enclosures, Inc.
2. Rittal
3. Bulletin A
4. E. M. Wiegman and Co., Inc.
5. Or Approved Equal

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, Type 1, except as noted below, with continuous hinge cover and flush latch. Key latch to match panelboards.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: PVC or fiberglass, finished inside with radio-frequency-resistant paint.

3. Application in other than NEMA 250, Type 1 environments:

a. Indoor Dusty Locations: NEMA 12.

b. Damp or Wet Locations: NEMA 3R.

c. Outdoor dirty/oily and washdown locations: NEMA 4, stainless steel.

d. Damp or Wet and Corrosive Locations: NEMA 250, Type 4X, stainless steel.

e. Hazardous Locations: NEMA 250, Type 7, 8, or 9 depending on hazardous area classification and location (unhinged).

2.3 CABINETS

A. Cabinets: NEMA 250, Type 1, except as noted below, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

1. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards.

2. Include metal barriers to separate wiring of different systems and voltage.

3. Include accessory feet where required for freestanding equipment.

4. Application in other than NEMA 250, Type 1 environments:

a. Indoor Dusty Locations: NEMA 12.

b. Damp or Wet Locations: NEMA 3R.

c. Outdoor dirty/oily and washdown locations: NEMA 4, stainless steel.

d. Damp or Wet and Corrosive Locations: NEMA 250, Type 4X, stainless steel.

e. Hazardous Locations: NEMA 250, Type 7, 8, or 9 depending on hazardous area classification and location (unhinged).

2.4 TERMINAL BLOCKS

A. Minimum 600-volt rating for 480-volt circuits.

B. Clamp or screw terminals sized for maximum conductor size.

C. Separate connection point for each conductor.

D. Ten percent spare terminal points.

E. Individual identification for each terminal block.

F. Phenolic block separators or barriers to isolate low-voltage and control terminations from analog and DC circuits.

G. Terminal Blocks: NEMA ICS 4.

H. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

I. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

J. Provide ground bus terminal block, with each connector bonded to enclosure.

PART 3 EXECUTION

3.1 GENERAL

A. Examine surfaces to receive enclosures, and cabinets for compliance with installation tolerances, access and working clearances. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 EXISTING WORK

A. Remove abandoned cabinets and enclosures. Patch surfaces.

B. Maintain access to existing cabinets and enclosures and other installations which remain active and which require access. Modify installation to provide access as appropriate.

C. Extend existing cabinets and enclosures using materials and methods as specified.

D. Clean and repair existing cabinets and enclosures which remain or are to be reinstalled.

3.3 INSTALLATION

A. Install enclosures and cabinets as indicated, according to manufacturer's written instructions and in accordance with NECA "National Electrical Installation Standards."

B. Install enclosures and cabinets plumb and level. Anchor securely under the provisions of Section 26 05 48 - Seismic Controls for Electrical and Communication Work.

3.4 IDENTIFICATION

A. Provide labels for enclosures and components as specified in Section 26 05 53 - Electrical Identification.

B. Control Panels: Include panel designation, power source location, panel designation and circuit number.

C. Equipment used in emergency systems shall be labeled "Suitable for use on emergency systems" per NEC 700-3.

D. Instructional signs: Install approved legend where instructions or explanations are required for system or equipment operation.

3.5 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

A. On completion of installation, clean electrical parts and remove conductive and harmful materials

B. Remove dirt and debris from enclosure.

C. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products.
6. Execution.

1.2 SCOPE

A. This Section specifies general use wiring devices consisting of receptacles, plugs, switches and appurtenances. Also covered in this section are plugs and receptacles used for motor disconnecting or isolation means. See also 26 28 16.16 for enclosed disconnect switches.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NEMA WD-1	General Requirements for Wiring Devices
NEMA WD-6	Wiring Devices - Dimensional
NFPA 70	National Electrical Code (NEC)
UL 20	General-Use Snap Switches
UL 498	Attachment Plugs and Receptacles
UL 514A	Metallic Outlet Boxes
UL 894	Switches for Use In Hazardous (Classified) Locations

Reference	Title
UL 943	Ground-Fault Circuit Interrupters
UL 1010	Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

PART 2 PRODUCTS

2.1 GENERAL

A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captive binding screws.

B. Provide devices colored to conform to manufacturer's or industry standard for special use such as orange for isolated ground receptacles, blue for surge suppression receptacles, and red for emergency power receptacles. Unless shown otherwise on the Drawings or Schedules, normal use devices shall be brown, except those located in finished areas shall be ivory.

2.2 RECEPTACLES AND PLUGS

A. GENERAL: Receptacles shall be grounding type.

B. 120V RECEPTACLES:

1. INDOOR, CLEAN AREAS: Unless shown otherwise on the Drawings or Schedules, receptacles shall be duplex 20 amp, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plugs. Where the manufacturer of cord connected equipment requires an isolated ground, a receptacle with isolated ground shall be provided.

a. Manufacturers: Hubbell 5362, 5362-AI or approved equal.

b. Isolated ground receptacle manufacturers: Hubbell IG-5362, Arrow- Hart IG5362, or approved equal.

c. Receptacles shall be white in occupied areas with white faceplate.

d. Receptacles shall be grey in un-occupied areas with chrome faceplate.

e. Receptacles shall be mounted at 18 inches above floor unless otherwise indicated on plan drawings.

2. OUTDOOR, PROCESS OR CORROSIVE AREAS: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, IP65/66/67, and shall accept NEMA 5- 15P and 5-20P plugs. Receptacle and plug shall be corrosion resistant, watertight, marine duty with yellow polycarbonate weatherproof lift covers.

a. Manufacturers: Hubbell 60W33H/15W33H, or approved equal.

3. INDOOR/OUTDOOR, GROUND FAULT CURRENT INTERRUPTING: receptacle shall be duplex, 20 ampere, NEMA 5-20R and shall accept NEMA 5-15P and 5-20P plugs. Receptacle shall have LED indication of device fault and tripped condition. Receptacles shall meet the 2006 UL 943 standard for surge testing (3kA, 6kV) and requirement for “no power to face when miswired.”

a. Manufacturers: Hubbell GF20Xx.

C. 250V RECEPTACLES: Receptacles shall be duplex 20 amp, NEMA 6-20R, and shall accept NEMA 6-20P plug caps. Receptacles shall be Hubbell 60W48H, or approved equal.

D. PLUG CAPS: Male plug caps for 120 volt and 250-volt receptacles shall be of the cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle. Plug caps shall be rated 15 amps. One plug cap shall be provided for every four receptacles furnished, with a minimum of two plug caps being provided. Plug caps shall be delivered to the Owner.

E. THREE PHASE RECEPTACLES AND PLUGS: Receptacles shall be suitable for 480 volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weather tight cap with chain fastener. Each receptacle shall be provided with one plug.

1. Plugs and receptacles used for motor disconnecting and isolating means must be approved for such use.

a. Non Metallic IP66/67 and NEMA 4X rated. Poly

b. Disconnect rated.

c. Provide units with current and HP ratings as required.

d. Receptacles to include dead front shutter that deploys automatically when receptacle is removed.

e. Plugs to be provided with spring assisted latching mechanism to secure in place when plugged into matching receptacle.

1) Latching mechanism to include quick release button.

f. Provide with two auxiliary / pilot contacts rated for 1.5 amps at 480 VAC.

1) Where shown on the drawings or required by specific equipment, provide additional pilot contacts as required and as available within the product line.

2. Manufacturers: Crouse-Hinds “Arktite,” Appleton “Powertite,” Meltric “DS” or “DSN” series approved equal.

F. RECEPTACLES FOR HAZARDOUS AREAS: Receptacles for use in hazardous areas shall be rated in accordance with NEC for the area in which they are to be located and shall be factory sealed. Receptacles shall be designed so the plug must be inserted and turned before load is energized. Receptacles shall be provided with mounting box, sealing chamber, and compatible plug. Voltage and current ratings shall be 120 Vac, 20-ampere.

1. Manufacturers: Appleton “U-Line,” Crouse-Hinds “Ark-Gard 2,” or approved equal.

2.3 SWITCHES

A. GENERAL PURPOSE (INDOOR, OCCUPIED AREAS): General purpose switches shall be rocker type, quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings or Schedules. Switches shall match receptacles in color. Voltage and current ratings shall be 120VAC, 20-ampere.

1. Manufacturers: General Electric, Hubbell, or Owner accepted substitute.

B. GENERAL PURPOSE (INDOOR, UNOCCUPIED AREAS): General purpose switches shall be toggle type, quiet AC type, specification grade, back and side wired, and shall be provided in accordance with rated capacities as required or as indicated on Drawings

or Schedules. Switches shall match receptacles in color. Voltage and current ratings shall be 120VAC, 20-ampere.

1. Manufacturers: General Electric, Hubbell, or Owner accepted substitute.

C. SWITCHES FOR HAZARDOUS AREAS: Switches for control of lighting and small single-phase power loads in hazardous areas shall consist of a factory assembled and sealed combination general purpose type switch in an explosion- proof housing. The switch shall be rated in accordance with NEC for the area in which it is to be installed. The external operating mechanism shall consist of a wing-type handle having the "ON" and "OFF" positions visible from the front.

1. Manufacturers: Crouse-Hinds EDS2129 series, Appleton EDS175 series, or approved equal.

D. SWITCHES FOR OUTDOOR AND CORROSIVE AREAS: Switches shall be 20- ampere with weatherproof/ corrosion resistant neoprene plate. Switches shall be mounted in "FD" type cast ferrous or cast ferrous PVC-coated boxes as specified.

1. Manufacturers: Hubbell or Arrow-Hart as follows:

Type	Hubbell with 17CM50 plate	Arrow-Hart with 2881 plate
Single-pole	1281	2991
Double-pole	1282	2992
3-way	1283	2993
4-way	1284	2994

2.4 DEVICE PLATES

A. RECEPTACLES AND SWITCHES (Occupied areas): Device plates shall be oversized, white, thermoplastic provided with switches. Lighting and exhaust fan switches located on the same wall shall share device plate.

B. RECEPTACLES AND SWITCHES (Un-Occupied areas):

1. In non-corrosive un-occupied indoor areas, device plates shall be made of sheet steel, zinc electroplated with chrome finish as manufactured by Crouse-Hinds, Appleton, or approved equal.

2. In corrosive indoor areas device plates shall be corrosion-resistant/marine- duty type. Plates shall be of the same manufacturer as the receptacle or switch.

3. In outdoor or wet areas receptacle covers shall provide while-in-use protection, rated NEMA 3R with cover closed. Covers shall be powder- coated cast zinc, with self-closing lid and stainless-steel hinges as manufactured by Leviton M5979 or approved equal.

4. Device plates for explosion-proof equipment shall be factory provided with the equipment.

C. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8-inch white characters on black background.

1. Nameplates for switches shall identify panel and circuit number and area served (if remotely switched).

2. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

PART 3 EXECUTION

3.1 GENERAL

A. Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

B. Receptacles and switches installed in sheet steel boxes shall be flush mounted. Flush mounted receptacles shall be located 18 inches above the floor unless otherwise indicated. Switch boxes shall be mounted 48 inches above the floor. Receptacles installed in cast device boxes shall be located 48 inches above the floor.

C. Wiring devices shall be tested for correct connections.

END OF SECTION

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SECTION 26 28 16.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions
5. Submittals.
6. Coordination.
7. Products.
8. Execution.

1.2 SCOPE

A. This section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Service disconnecting means.

2. Feeder and branch-circuit protection.

3. Motor and equipment disconnecting means.

1.3 REFERENCE STANDARDS

A. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.

B. NEMA FU1 (National Electrical Manufacturers Association) - Low Voltage Cartridge Fuses.

C. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. NETA ATS (National Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

E. NFPA 70 (National Fire Protection Association) - National Electrical Code.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment first start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RMS: Root mean square.

C. SPDT: Single pole, double throw.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

4. Field Test Reports: Submit written test reports and include the following:

    a. Test procedures used.

    b. Test results that comply with requirements.

    c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

5. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1 General Requirements. In addition to requirements specified in Section 01 77 00 - Project Closeout include the following:

    a. Routine maintenance requirements for components.

    b. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.

    c. Time-current curves, including selectable ranges for each type of circuit breaker.

6. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

    d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

7. Shop Drawings: For each switch and circuit breaker.

    a. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

        1) Enclosure types and details for types other than NEMA 250, Type 1.

        2) Current and voltage ratings.

        3) Short-circuit current rating.

        4) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

        5) Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

8. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches, accessories, and components will withstand seismic forces defined in Section 01 41 20.

    a. Basis of Certification: Verify whether withstand certification is based on actual test of assembled components.

        1) The term “withstand” means “the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.”

    b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

    c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton

2. General Electric

3. Group Schneider/Square D

4. Siemens

5. Or Approved Equal

2.2 ENCLOSED CIRCUIT BREAKERS

A. Enclosed Circuit Breakers

1. Ground Fault protection type:

a. Required for solidly grounded wye service entrance switches over 150 Volts to ground, not exceeding 600 Volts and rated 1000 Amps and above.

2. Switch Duty (SWD) rated type for switching lighting fixtures. Note that energy code restricts use of circuit breakers as sole means of switching lighting circuits

3. Auxiliary contacts: Provide as required by engineering considerations.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.

    b. Long- and short-time pickup levels.

    c. Long- and short-time time adjustments.

    d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and two-pole configurations with 5 mA or 30 mA trip sensitivity.

7. Molded-Case Switch: Molded-case circuit breaker without trip units.

C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted, Integral communication module with functions and features compatible with power monitoring and control system.

5. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

6. Auxiliary Switch: Two SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

D. Service Entrance: For enclosed circuit breakers identified for use as service equipment, provide solid neutral assembly and equipment ground bus.

2.3 ENCLOSURES

A. NEMA AB 1, NEMA KS 1 and UL 50 to meet environmental conditions of installed location.

1. Indoor Clean Locations: NEMA 250, Type 1.

2. Indoor Dusty Locations: NEMA 250, Type 12.

3. Indoor Wet or Damp Locations and Outdoor Dirty/Oily or Washdown Locations: NEMA 250, Type 4.

4. Outdoor Locations: NEMA 250, Type 3R.

5. Corrosive Locations: NEMA 250, Type 4X, stainless steel.

6. Hazardous Areas Indicated on Drawings: NEMA 250, Type [7] [8] [9].

2.4 FACTORY FINISHES

A. Manufacturer’s standard prime-coat finish ready for field painting.

B. Finish: Manufacturer’s standard paint applied to factory-assembled and tested enclosures before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 70 working space requirements and NECA 1.

B. Standard Mounting Height: Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Operating handle typically at 5’-0” above grade or finished floor.

C. Mount on substantial structure and secure to meet seismic zone 3 requirements. Comply with mounting and anchoring requirements specified in Section 01 41 20 - Seismic Requirements for Non-Structural Components and Systems.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Set adjustable parameters and provide testing and calibration as required by engineering considerations.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 - Electrical Identification.

B. Install enclosure nameplate with switch or circuit breaker designation, power source, source location, voltage, load served and load location.

1. Identify special conditions for shutting down load served.

C. Apply label inside door cover identifying NEMA fuse class and size of fuses installed.

D. Equipment used in emergency systems shall be labeled “Suitable for use on emergency systems” per NEC 700-3.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

1. Mark lugs after torqueing with red paint such that paint will be visibly disturbed if lugs are disturbed.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to initially inspect, test, and adjust components, assemblies, and equipment installations, including connections. Verification will be by third party testing agency.

B. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.

2. Test continuity of each line- and load-side circuit.

C. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

END OF SECTION

SECTION 26 29 24 - ACTIVE FRONT END VARIABLE FRQUENCY CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Products Requirements.
6. Coordination.
7. Products.
8. Execution.

1.2 SCOPE

A. A. This specification specifies low voltage, active front end, adjustable frequency drives (AFDs), and variable frequency drives (VFDs). For the purpose of this specification the terms AFD and VFD are interchangeable and equivalent.

B. The Variable-frequency Drive (VFD) system for motors rated 30Hp and larger shall use an Active Front End (AFE) Low Harmonic design and shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.

Units shall utilize an insulated gate bipolar transistor (IGBT) technology as the input rectifier unit. This system shall be designed and configured such that IEEE 519 harmonic emission limits are inherently met without the need for external mitigation devices such as line reactors or filters.

C. Refer to the drawings for control and monitoring requirements including special interlocking requirements.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI/IEEE C37.30A(1984)	Definitions and Requirements for High- Voltage Air Switches, Insulators, and Bus Supports, Supplement to C37.30-1971
ANSI C37.32	Schedules of Preferred Ratings, Manufacturing Specifications and Application Guide for High-Voltage Air Switches, Bus Supports, and Switch Accessories
NEMA ICS-1	Industrial Control and Systems General Requirements
NEMA ICS-2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
NEMA ICS-3	Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC
NEMA ICS-3.1	Safety Standards for Construction and Guide for Selection, Installation and Operation of Variable-speed Drive Systems
NEMA ICS-4	Terminal Blocks for Industrial Control Equipment and Systems
NEMA ICS-6	Enclosures for Industrial Controls and Systems
ANSI C37.90	Relays and Relay Systems Associated with Electric Power Apparatus
IEEE 519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
NFPA 70	National Fire Protection Association – US National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for a period of twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design, workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

5. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

6. Installation instructions, outline dimensions and weights including filters and/or phase shifting autotransformers, front view drawing identifying control and monitoring devices, nameplate engravings, shipping section dimensions, weight, and foundation requirements or wall mounting requirements for all assemblies.

7. External connection diagram showing function and identification of all terminals requiring field connections.

8. O&M manuals per Section 01 33 00 and Section 26 05 00.

9. Product Data Sheets

    a. VFD and Operator Interface publications.

    b. Data sheets and publications on all major components including, but not limited to, the following:

        1) Contactors
        2) Circuit breaker and fuse (power and control)
        3) Control power transformers
        4) Pilot devices
        5) Relays/Timers

10. Schematics and wiring diagrams.

11. Plan drawings showing conduit entry locations.

12. Current and voltage distortion calculations.

    a. Point of Common Coupling (PCC)

    b. Include first 36 odd current and voltage harmonics. Voltage shall be calculated on line-to-line basis.

    c. Provide distortion figures for each harmonic and the total demand distortion.

13. Efficiency and power factor calculations:

    a. Calculate efficiencies of the VFD controller including the auto- transformer (where applicable), ventilation fans, control power and all VFD losses.

    b. Calculate displacement and total power factor including filter.

    c. Perform calculations at 100, 75, and 50 percent speed.

    d. Include first 36 harmonics.

14. Harmonic Analysis Report that is project specific and includes the manufacturers statement of compliance with IEEE 519

15. Calculations of cooling and ventilation requirements.

16. Certified final factory test procedure and results for each drive.

17. Location and description of service center and spare parts stock.

18. Recommended spare parts list.

19. Factory and field test documentation.

20. Training schedule and materials.

21. Written descriptions explaining ladder diagram operation, system operation, and analog signal processing.

22. Comprehensive interconnection diagrams for VFD and motor.

23. In accordance with seismic anchoring requirements:

    a. Certification of compliance with local code and seismic designation.

    b. A sketch or description of the anchorage and restraint system.

24. Certification that VFD, motor, and driven load are compatible throughout the specified speed range.

25. Certified statement from the manufacturer accepting responsibility for providing a fully functioning installation as specified herein.

1.6 PRODUCT REQUIREMENTS

A. The VFD system shall convert 460 volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium efficient, inverter duty, squirrel- cage induction motor to run at a speed proportional to an external input analog 4 to 20 ma dc or digital input command as specified for the required VFD speed range.

B. The VFD system shall include converter units, inverter units, control circuitry, protective equipment, LCL filters and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave. Unless otherwise specified, the point of common connection for VFDs shall be the 480V-distribution bus (motor control center, distribution panel, etc.) immediately upstream of the VFD. Provide load side Reactors, dv/dt filters, or sine wave filters as shown on the drawings.

C. Active Front End Low Voltage Adjustable Frequency Drives.

1. Listed and labeled by Underwriter's Laboratories, Inc. (UL), ETL, or Factory Mutual (FM).

    a. All upgrades to specified requirements per UL or ETL.

2. QUALITY ASSURANCE: The Owner reserves the right to observe factory tests on the VFD controller at the Owner's option and expense.

    a. All inspection and testing procedures shall be developed and controlled under the guidelines of the supplier's quality control system and must be registered to ISO 9001 and audited by a third-party registrar.

3. COMPATIBILITY: VFD controller's performance shall be compatible and tolerant of disturbances produced by other VFD controllers and not interfere with each other.

4. PROGRAMMING: Provide VFD controller configuration and MACRO or sub-routine programming to meet specified driven equipment requirements.

5. MAINTAINABILITY: VFD controller's parts shall be interchangeable and modular for all controllers.

D. FACTORY TEST: Subject complete VFD system to a complete simulated operational test. Drive a calibrated load at various speeds over the specified speed range to determine VFD efficiency.

1.7 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 COORDINATION

A. Obtain and review the appropriate data for the driven motor and load over the required speed range, for a complete system analysis. Verify that equipment is mutually compatible and free of resonance over the complete operating range. Coordinate the assignment of any critical frequencies with the equipment suppliers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Variable frequency drives shall be as manufactured by the vendor listed below. The Owner will not consider substitutions. To conform with specified requirements, a manufacturer's standard product may require modification.

1. Allen Bradley Powerflex 755 TL

2.2 SYSTEM

A. The System shall use a transistor-based Active Front End as the input rectifier that uses a Selective Harmonic Elimination algorithm, mitigating the harmonics enough to meet IEEE-519-2014 without the need for phase shifting transformers and multi-pulse diode rectifiers. Total current harmonic distortion shall not exceed 5% at the VFD input terminals at full load conditions. AFE rectifier shall be phase rotation insensitive, tolerant of line voltage imbalance up to 10% without affecting the harmonic mitigation or VFD output, and capable of operating the motor at full output with a 10% drop on input voltage.

B. The unit shall use an LCL filter assembly to filter up to and including the 50th harmonic to reduce EMI/RFI emissions. The LCL filter assembly shall include Passive Dampening. The drive will provide Active Resonance Detection and Protection to minimize any damage to the drive from supply side resonance: Provide integrated, all solid-state variable frequency drives (VFD). Provide all components, with terminal numbers as shown on the Drawings.

C. Operation: Accomplish speed control by adjusting the output frequency according to the desired reference speed. Adjust ac voltage and frequency simultaneously to provide the constant Volts/Hertz necessary to operate the motor at the desired speed. The VFD must use pulse width modulation (PWM) technology.

D. The drive shall have a built-in circuit breaker as part of the drive's pre-charge circuit (250 hp and up) or provide built-in electrical connections for one to be field connected (10hp-250hp).

E. The drive will have two sets of tuning settings for the configuration of the line side converter such that appropriate values can be selected for two input sources (example: main utility power or back-up generator) and can be selected from the Human Interface Module or communications network

F. The VFD shall meet the voltage sag ride-through requirements of SEMI-F47.

G. Incorporate phase-to-phase and phase-to-ground MOV protection on the AC input line.

H. Microprocessor-based inverter and converter logic shall be isolated from power circuits.

I. Use latest generation IGBT inverter and converter sections that shall not require commutation capacitors.

J. Motor side inverters, line side converters and LCL filter modules (for drives greater than 250 Hp) shall be on roll-out chassis with front accessible connections for ease of repair or replacement and to provide access to load cables. Motor side inverter modules shall be removable without disturbing the load cables after installation.

K. Line converter modules and load inverter modules sections (for drives greater than 250 Hp) shall be interchangeable so as to reduce necessary spare parts.

L. Rating:

1. Line Voltage: 480 volts, -5 percent continuous, -10 percent momentary, +10 percent, 3- phase.

2. Line Frequency: 60 Hz, ±2 Hz

3. Ambient Temperature: 5°C to 40°C

4. Altitude: Up to 3,300 feet above sea level.

5. Power Factor: Above 0.95 at full speed and rated load.

M. Duty rating

1. For pump and fan duty, VFDs may be of a standard rating.

2. For constant torque applications like conveyors and cranes, VFDs shall be Heavy Duty rated.

N. Performance:

1. Efficiency: Above 95 percent at 100 percent full speed, above 93 percent at 70 percent full speed.

2. VFD Inrush Current: Limited to less than 100 percent of motor full load

3. Duty Cycle: 6 starts per hour.

4. Flying Start: The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to “pick-up” the motor at the rotating sped.

O. Features:

1. Provisions to accept the following control signals for automatic and manual operation:

    a. Ethernet communications port support Ethernet/IP protocol. All operating parameters and control functions shall be accessible via Ethernet communications.

    b. FWD & REV Run signal from a single remote contact closure when specified

    c. A 4-20 mA dc signal for speed control. The VFD shall provide linear speed control of the motor from zero to full speed as the variable speed input signal varies from its minimum to maximum. Input impedance shall be 250 ohms resistive.

2. Have a lineside converter input frequency range from 47 to 63 Hz

3. The carrier frequency of the lineside converter shall be fixed at 4 kHz.

4. The motor side inverter frequency output will be sine coded PWM with a carrier frequency that can be selected at 1.33 kHz, 2 kHz, or 4 kHz.

5. The VFD motor side inverter shall be capable of the following maximum frequency outputs:

    a. 325 Hz when operating with an output carrier frequency of 1.33kHz or 2 kHz.

    b. 590 Hz when operating with an output carrier frequency of 4kHz

6. Use gold plated plug-in connections on printed circuit boards.

7. Motor speed indicator calibrated in percent of full speed.

8. A 4-20 mA dc signal for remote speed indication to a local PLC. The VFD shall provide linear speed indication of the motor speed from zero to full speed. Input impedance shall be 250 ohms resistive.

9. A 4-20 mA dc signal for remote motor current indication to a local PLC. The VFD shall provide linear current indication of the motor from zero to full current. Input impedance shall be 250 ohms resistive.

10. Incoming line fused lockable disconnect or lockable main circuit breaker.

11. VFD rated High speed fuses.

12. 24 VDC control circuitry and 480V-120V step down transformer.

13. Variable time delay for delaying motor drive restart after power failure; timer range shall be 0 to 120 seconds, with initial settings differing by 10 seconds for each drive; provide module which causes multiple attempts to restart.

14. Provision for automatic emergency shutdown in any mode, activated by the following:

    a. Any additional abnormal conditions as shown on the Drawings. Provide for manual restart.

15. Auxiliary contacts for remote indication of “Run” and “VFD Fault.”

16. VFD operable with motor disconnected, in order to test VFD.

17. Linearity and repeatability accuracy of 3 phase output of 1 percent of analog input control signal regardless of input power voltage fluctuations between 437 and 505 volts.

18. Independent acceleration and deceleration controls, adjustable from 2 to 30 Hz per second.

19. Label with fault current rating per NEC article 409.110 and arc flash warning label per NEC Article 110.16.

P. Motor Control

1. Selectable Sensorless Vector, Flux Vector, V/Hz, economizer mode selectable through programming.

2. The drive shall be supplied with an auto-tune mode.

3. The V/Hz mode shall be programmable for fan curve or full custom patterns.

4. Capable of Open Loop V/Hz.

5. Capable of operating induction and permanent magnet motors

Q. Protection: Protect VFD against the following conditions:

1. Reverse phase sequence and single phasing of input power.

2. Input power failure.

3. Input transient voltages, including peak suppression and snubbers, in accordance with ANSI C37.90.

4. Transmission signal interference.

5. Output overcurrent.

6. Input overcurrent.

7. Motor over temperature.

8. Cabinet over temperature.

9. Under voltage: VFD shall automatically shut down if input voltage falls below preset limit with automatic restart upon return to a stable supply.

R. Enclosure Door Mounted Human Interface Module (HIM)

1. VFD shall provide a HIM with integral LCD display, operating keys and programming keys.

2. An enclosure door-mounted HIM, rated UL Type 12, shall be provided

3. The HIM shall have the following features:

   a. A four (4) to seven (7) line backlit LCD display with graphics capability.

   b. Shall indicate drive operating conditions, adjustments and fault indications.

   c. Shall be configured to display in the following:

   d. One zone shall display the status of direction, drive condition, fault / alarm conditions and Auto / Manual mode.

   e. Another zone shall display drive output frequency, voltage or current.

   f. Another Zone shall display one of 6 to 12 user selected values such as power, torque, DC bus voltage, Analog values, discrete I/O status and etc.

   g. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.

S. Enclosure Door Mounted Operators

1. Hand-Off-Auto selector switch

2. Run and Fault indicating pilot lights

T. Construction:

1. All stand-alone VFDs provided for this project shall be of the same manufacturer chosen from Paragraph 2.1 above.

2. Where shown on the drawings, AFE VFDs shall be furnished with free-standing enclosure housing controller modules and components rated NEMA 12, and fabricated from steel, 12-gauge minimum. The enclosure shall be dead front and dead back construction with all modules, components, load, line, and control terminations fully front accessible. The enclosure shall be completely self-ventilated and have provision for top and bottom entry of wiring and conduits. The controller enclosure shall have gasketed doors mounted on semi-concealed hinges, with lockable door latches.

3. VFDs mounted in motor control centers (MCCs) shall be of the same manufacturer as the MCC.

    a. Door-mount the following devices:

        1) HIM with the following indications:

            a) Power On
            b) Speed indication
            c) Motor Run
            d) VFD Fault Indication
            e) External operating handle for the incoming line fused disconnect.

    b. Control enclosures and components shall be in accordance Section26 27 16, Cabinets & Enclosures and applicable portions of 40 61 13, Process Control System General Provisions. Configuration of the enclosure and the components shall be as shown on the drawings.

    c. Components: Mount components on circuit cards or modules, which can be adjusted or replaced in the field without the use of special tools.

    d. Finish: Paint finish shall be ANSI Grey.

U. Spare Parts: Furnish two sets of spare power fuses for each size and type of fuse used; furnish a minimum of five fuses of each size and type of control circuit fuse.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 26 05 00 and install in accordance with manufacturer's instructions for the specified functional requirements.

B. Properly level and plumb VFDs so that doors will open and close freely.

C. Clean and repair scratched or damaged surfaces to "new" condition.

D. Provide the services of a factory trained service technician to inspect and check out each system before energizing.

E. Per manufacturer's instructions, lace power conductors to resist short circuit forces.

3.2 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 77 00 - Project Closeout 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

3.5 COMPONENT TEST PHASE

A. PROCEDURES: Section 01 75 16

B. Operate each drive from no load to full load and perform a spectrum analysis to verify that the waveform on the line side of the VFD is in compliance with IEEE 519 for general systems.

3.6 MANUFACTURER'S SERVICES

A. ON-SITE INSPECTIONS AND TRAINING: Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from the Site.

1. INSTALLATION INSPECTIONS: Assist, supervise, and inspect the Contractor's activities during installation. Provide minimum 2 hours of installation inspection for each VFD provided. If installation deficiencies are found, provide follow up inspections as required until a certificate of proper installation can be issued.

2. PROGRAMMING: Provide programming of each VFD to operate as intended by the design and required by the installation. This includes but is not limited to the following:

a. Set all VFD parameters as required for the installation. This includes

1) Motor nameplate information

2) Standard and optional VFD I/O configuration settings to match installed environment

3) Tune the VFD for the motor connected.

a) Provide spinning tune if possible and static Motor ID and tune if operating motor is not possible.

3. TRAINING SESSIONS: Procedures: Section 01 75 16. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend. Training must meet the requirements of division 01 and division 40 general conditions as well as the specific requirements included herein.

a. Training to include providing a written copy of all non-default VFD settings as well as step by step instructions for making setting changes via the keypad or using vendor provided configuration software.

END OF SECTION

SECTION 26 32 13 - DIESEL-ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Submittals.
5. Product Requirements.
6. Installation.
7. Testing.

1.2 SCOPE

A. This Section includes packaged engine-generator sets suitable for use in mission critical applications with sub-base diesel tank and fuel transfer pump as specified and indicated. Engine generators will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.

B. Ensure required control and status signals are present and align on a per point basis between the generator and the ATS.

1.3 REFERENCE STANDARDS

A. NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

B. NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

C. NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

D. Comply with UL 2200.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. Manufacturer Qualifications: Engage a firm experienced in manufacturing equipment of types and capacities similar to those indicated for this Project and with a service

center maintained by engine generator set manufacturer capable of providing training, parts, and emergency maintenance and repairs at the Project site with 24 hours maximum response time.

C. Source Limitations: Obtain engine generator set and auxiliary components from a single manufacturer with responsibility for entire system.

D. Listing and Labeling: Provide system components of types and ratings for which listing or labeling service is established and components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 704, Hazard Identification signage.

H. Engine Exhaust Emissions: Comply with applicable federal, state, and local government requirements.

1. Tier 4 emission limits generally apply for units under 75 KW.

2. Tier 3 emissions limits generally apply for units from 75 KW to 700 KW.

3. Tier 2 emission limits generally apply for units 750KW and larger.

a. Above ranges may vary depending on actual diesel engine ratings.

I. The manufacturer shall warranty the above specified equipment for 5 years from equipment start-up and commissioning to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained

in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

C. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

D. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

3. Sound test data, based on a free field requirement as measured and not calculated

E. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Wiring Diagrams: Control interconnection, Customer connections.

F. Load Calculations

1. Provide manufacturers load calculations that demonstrate the generator has been properly sized for the application.

   a. Obtain load information from the one line diagram and or the load summary.

   b. Develop step and load starting sequence that corresponds to the logical operation of the facility.

      1) Step sequencing shall assume all hardwired and non-automated equipment starts on step one.

      2) Subsequent steps shall begin with starting of largest motors first and then transition to smaller motors.

      3) Step sequence to be confirmed by the owner and engineer.

G. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

2. Submit statement of compliance which states the proposed product(s) are seismically certified in compliance with local requirements signed and sealed by a qualified professional engineer.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that the fuel tank, the Sound Attenuated enclosure, engine-generator set, and components will withstand seismic forces defined in 01 41 20 and including the following:

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.

2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.

3. List of factory tests to be performed on units to be shipped for this Project.

4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 0.0 deg F to 110.0 deg F.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1200.0 feet (366.0 m).

1.8 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, equal units by Caterpillar and Kohler may be considered if equipment performance is shown to meet the requirements herein.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 275 kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.

2. Alternator shall be capable of accepting maximum1210.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.

3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: not more than 3 percent variations for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 3 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic.

Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.

9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

10. Load Sharing: Engine generator shall share real and reactive load proportionally within plus or minus 3 percent with all other engine generators in the system.

2.3 ENGINE

A. Fuel: ASTM D975 #2 Diesel Fuel

B. Rated Engine Speed: 1800RPM.

C. Lubrication System: The following items are mounted on engine or skid:

1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.

2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer’s instructions

E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.

1. Designed for operation on a single 120 VAC, Single phase, 60Hz power connection. Heater voltage shall be shown on the project drawings.

2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.

3. Provided with a 120 VAC thermostat, installed at the engine thermostat housing

G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

H. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.

2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure

requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

1. Exhaust Systems shall provide noise reduction in compliance with Critical Grade requirements providing a minimum of 30 dBA reduction of noise.

2. Exhaust Silencers shall have high temp black paint finish for corrosion resistance.

3. Make provisions as required for pipe expansion and contraction. Contractor shall cover exhaust silencers (where mounted indoors) and all indoor exhaust piping with a proper insulating material in a manner not to interfere with flexible exhaust connection(s).

4. Provide flexible exhaust connection as shown for connection between engine exhaust manifold(s) and exhaust line. Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensation from entering the engine.

J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

K. Starting System: 24VDC with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Cycle: As required by NFPA 110 for level 1 systems.

3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.

4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.

6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:

   a. Operation: Equalizing-charging rate based on generator set manufacturer’s recommendations shall be initiated automatically after battery has lost charge

until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 2085 listed and labeled in non-secure areas and UL-142 rated in areas where vandalism and physical damage are not likely. The fuel tank shall include the following features:

1. Capacity: 500 gallons of fuel for 24 Hour(s) continuous operation at 100 percent rated power output.

2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.

3. Electrical stub up(s)

4. Normal & emergency vents

5. Lockable fuel fill

6. Mechanical fuel level gauge

7. High and low level switches to indicate fuel level

8. Leak detector switch

9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 130% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.

10. Fill port with overfill prevention valve (OFPV)

11. 5-gallon fill/spill dam or bucket

12. Tank design shall meet the regional requirements for the Project location

2.5 CONTROL AND MONITORING

A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter (3-phase, line to line and line to neutral values).

2. AC ammeter (3-phases).

3. AC frequency meter.

4. AC kW output (total and for each phase). Display shall indicate power flow direction.

5. AC kVA output (total and for each phase). Display shall indicate power flow direction.

6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.

7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.

8. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.

9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.

10. DC voltmeter (alternator battery charging).

11. Engine-coolant temperature gauge.

12. Engine lubricating-oil pressure gauge.

13. Running-time meter.

14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control adjustment of these parameters shall be in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.

15. Fuel tank derangement alarm.

16. Fuel tank high-level shutdown of fuel supply alarm.

17. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault

alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.

18. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.

19. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.

20. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

21. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.

22. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

23. Paralleling Breaker control switches: The control shall include manual open and close provisions for the paralleling breaker, and LED status lamps indicating whether the breaker is open or closed.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.

2. Coolant low-temperature alarm.

3. Control switch not in auto position.

4. Battery-charger malfunction alarm.

5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Main Circuit Breaker: Provide a generator mounted circuit breaker, molded case, 3 pole, NEMA 1/IP22, which will disconnect the generator from the supply circuit. Circuit breaker to be sized as shown. Breaker shall utilize a solid-state trip unit and shall have the electrical characteristics, rating, and modifications as shown. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set and shall have a metal nameplate that contains a permanent record of the circuit breaker catalog number and maximum ratings. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker.

1. Circuit breaker trip system shall be a microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13^{th}) harmonic. Sensor ampere ratings shall be as indicated on the associated drawing. The solid-state trip circuit breaker shall include the following adjustments; each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments:

    a. An ampere trip setting (long time pickup) that is adjustable from 0.5 times (or less) to 1.0 times the plug ampere rating, in 0.1 (or less) increments.

    b. An adjustable long time pickup delay, with a minimum of 5 different delay settings.

    c. A short time pickup trip setting that is adjustable from 2 times (or less) to 9 (or greater) the long time ampere trip setting.

    d. An adjustable short time pickup delay, with a minimum of 5 different delay settings.

    e. An instantaneous pickup that is capable of being disabled (preferable) or is adjustable from 1.5 times (or less) to 15 times (or greater) the long time ampere trip setting. Units that are capable of disabling the instantaneous pickup shall be configured with the instantaneous pickup disabled.

2. Main Circuit Breaker shall have a quick-make, quick break, over-center toggle type, trip-free mechanism to prevent holding contacts closed against a position between "ON" and "OFF" when tripped automatically. Breaker shall be common trip such that an overload or short circuit on any one pole will result in all poles opening simultaneously.

3. The interrupting capacity of the Main Circuit Breaker shall be 42 kAIC at 480 volts, minimum.

B. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:

1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.

3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.

4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.

5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.

6. The protective system provided shall not include an instantaneous trip function.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Temperature Rise: 125 / Class H environment.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.

G. Enclosure: Drip-proof.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure. Rating of enclosure shall be no more than 73 DBA @ 7-meters when operating at 100% load, as measured in a free field.

B. Construction:

1. Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.

2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.

3. Exhaust System:

   a. Muffler Location: Within enclosure.

4. Hardware: All hardware and hinges shall be stainless steel.

5. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.

6. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.

7. Inlet ducts shall include rain hoods

C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.

1. Louvers: Fixed-engine, cooling-air inlet and discharge.

D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 70 dBA measured at any location 7 m from the engine generator in a free field environment.

E. Provide a circuits from the MCC panelboard to serve the engine generator and enclosure; including:

1. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.

2. Factory wired normal AC service to the engine coolant heater, alternator heater, and battery charger.

3. Interior Lights with Switch: Two three-way switches controlling two LED lamps mounted in vapor tight and gasketed fixtures.

F. Site Provisions:

1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.9 VIBRATION ISOLATION DEVICES

A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

1. IBC Compliance: Isolators complying with IBC requirements shall be specified in the equipment documentation, as well as the installation requirements for the unit.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer’s standard color or as directed on the drawings.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Steady-state governing.

6. Single-step load pickup.

7. Simulated safety shutdowns.

8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.

B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.3 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 77 00 - Project Closeout 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

3.5 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by

Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.

B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.6 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise installation and connection of the generator-set unit and to report results in writing.

B. Supervised Adjusting and Pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive load bank simulating kW of loads for which unit is rated.

3.8 SERVICE AND SUPPORT

A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of $3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 2 hours from the site.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.9 SPARE PARTS

A. Provide the following spare parts for each generator unit

1. Three sets fuel oil filter elements and gaskets.

2. Three lubricating oil filter elements and gaskets.

3. One air cleaner filter element.

4. One set of coolant hoses

5. Two sets V-belts for accessories

6. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.

3.10 SERVICE AGREEMENT

A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine generator set. This agreement shall include the following:

1. Generator supplier must have an in-house rental fleet with equipment sized to back up this project site.

2. All engine maintenance as recommended by the service manual.

3. All electrical controls maintenance and calibrations as recommended by the manufacturer.

4. All auxiliary equipment as a part of the emergency systems.

5. The supplier shall guarantee emergency service.

6. All expendable maintenance items are to be included in this agreement.

7. A copy of this agreement and a schedule shall be given to the Owner at the time of his acceptance, showing what work is to be accomplished and when.

END OF SECTION

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. System Requirements
3. Quality Assurance
4. Submittals
5. Products
6. Installation
7. Testing

1.2 SCOPE

A. The Contractor shall furnish and install Automatic Transfer Switch (ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the drawings. Each automation transfer shall consist of a contactor style or inherently double throw power transfer switch mechanism and a microprocessor controller, interconnected to provide complete automatic operation.

B. Coordinate with the Generator Supplier to ensure proper interconnection of the generator and ATS and generator and that proper operation of the generator will be assured.

1.3 SYSTEM REQUIREMENTS

A. The ATS shall be Rated for use at 480 VAC, 600 amps with a withstand rating of 65,000 AIC unless otherwise shown on the drawings. Unit shall be 3-pole with a solid neutral unless shown or specified differently on the drawing. Unit shall be Delayed Transition style.

1.4 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean

the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

1. UL 1008 - Standard for Automatic Transfer Switches
2. CSA 22.2 No 178
3. IEC 60947-6-1
4. NFPA 70 - National Electrical Code
5. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
6. NEC Articles 700, 701, 702
7. NFPA 110 - Emergency and Standby Power Systems
8. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
9. International Standards Organization ISO 9001: 2008
10. UL 508 Industrial Control Equipment

1.5 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

5. Installation instructions, outline dimensions and weights, front view drawing identifying control and monitoring devices, nameplate engravings, shipping dimensions, weight, and wall mounting requirements.

6. Certification from the project generator supplier that the ATS provides all the features and functions required to monitor and control their generator adequately.

7. Component list

8. Conduit entry/exit locations where applicable

9. Assembly ratings including:

    a. Short-circuit rating

    b. Voltage

    c. Continuous current

10. Cable terminal sizes

11. Product data sheets, external connection diagram showing function and identification of all terminals requiring field connections.

12. O&M manuals per Section 01 33 00 and Section 26 05 00.

13. Schematics and wiring diagrams.

14. Recommended spare parts list.

15. Factory test documentation.

16. In accordance with seismic anchoring requirements:

    a. Certification of compliance with local code and seismic designation.

    b. A sketch or description of the anchorage and restraint system.

1.7 DELIVERY, STORAGE AND HANDLING

A. PROCEDURES: Section 01 66 00

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

C. Store indoors in clean dry space with uniform temperature to prevent condensation and per manufacturer's recommendations. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURES/PRODUCTS

A. Candidate manufacturers and models are listed below. To conform to specified requirements, the manufacturer's standard product may require modification.

    1. Asco 7000 Series

    2. Approved Equal

2.2 AUTOMATIC TRANSFER SWITCH

A. Furnish and install where indicated a "programmed (delayed) transition" style, 3-pole (with solid neutral) automatic transfer switch with ratings, features, accessories, enclosures, etc. indicated on the drawings or noted herein

B. The transfer switch equipment as specified herein shall be 100% equipment rated for continuous duty at the ratings shown on the plans and shall conform to the applicable requirements for UL 1008 for emergency total system load. All transfer switch equipment supplied shall bear the UL label.

C. All main power contacts shall be rated for multiple fault interruptions per UL 489, and/or UL 1087. Main contacts shall have independent “break-before-make” transfer action which shall positively prevent dangerous “source-to-source” connections.

D. Automatic transfer switches specified herein shall consist of completely enclosed contact assemblies and a separately mounted control logic panel. Control power for all automatic transfer operations shall be derived from the line side of the source to which the load is being transferred.

E. Upon loss of phase-to-phase voltage of the normal power source on any phase to 70% of nominal, and after a time delay of 0-5 seconds (adjustable to meet conditions present) to override momentary dips and/or outages, starting of the emergency/standby power source shall be initiated. Transfer to the emergency standby power source shall take place 2-60 seconds (adjustable) after attainment of 90% of rated voltage and frequency of that source.

F. When the normal power source has been restored to 90% of rated voltage and after a time delay adjustable from 0-30 minutes (to ensure the integrity of the normal power source), the load shall be retransferred to the normal source.

G. A time delay, adjustable 0-10 minutes, shall delay shutdown of the emergency/standby power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.

H. If the emergency/standby power source should fail while carrying the load, transfer to the normal power source shall be made instantaneously upon restoration of the normal source to satisfactory conditions.

I. The following features/accessories shall be provided:

1. Auto/test switch to provide test operation of the automatic transfer switch by simulating a loss of the normal power source.

2. Pilot lights to indicate to which source the load is connected.

3. Pilot lights to indicate that an integral overcurrent protective device has tripped.

4. Plant exerciser timer providing automatic test operation of the emergency/standby power source at pre-selected intervals at least once per week, including a selector switch to select exercise with or without load or a bypass of the exercise period. The clock timer shall be provided with a digital readout and include a lithium

battery backup to assure continuity of power to the clock timer for a minimum of 72 hours during an outage.

5. Provide “dry”, form C contacts for the following conditions, as a minimum. Contacts shall be rated 10 Amps at 120 VAC:

    a. ATS in “Normal” position
    b. ATS in “Generator” position
    c. “Normal” power source available
    d. ATS failure (common failure alarm)

PART 3 PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 26 05 00 and Installation in accordance with manufacturer's instructions for the specified functional requirements.

B. Automatic Transfer Switches shall be installed, configured and tested on site in accordance with the requirements of Section 26 05 00 and in accordance with the manufacturer’s recommendations. Field Setup shall be conducted by a technical representative, factory trained and certified by the manufacturer.

C. CONTRACTOR shall provide the services of the manufacturer’s representative for a minimum of one day for the calibration and testing of the equipment after certification of proper installation.

3.2 DAMP AND WET LOCATIONS

D. Unless otherwise specified, all electrical enclosures in damp and wet locations shall be NEMA 4, stainless steel.

E. All conduit entries into equipment located in damp or wet locations shall be through the bottom or lower sides of enclosures. Top entry of conduits will not be allowed.

3.3 TESTING

A. Service Equipment shall be tested for proper operation and function in accordance with Section 26 08 00.

B. Coordinate with Generator supplier to provide an integrated test to demonstrate ATS senses loss of utility power, starts the generator, verifies the electrical output from the generator is valid and transfer the load to the standby power source.

Verify also that restoring Utility power is sensed appropriately by the ATS and that after the selected time delay, restores utility power to the generator. Verify proper generator cool down run time is provided for either in the generator or in ATS settings.

C. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

D. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

END OF SECTION

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SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW- VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope.
2. Reference Standards.
3. Quality Assurance.
4. Definitions.
5. Submittals.
6. Products.
7. Execution.

1.2 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers (MCC).

B. Provide a transient voltage suppression system that is suitable for application in IEEE C62.41 Category A, B and C3 environments, as tested by IEEE C2.11, C62.45.

1.3 REFERENCE STANDARDS

A. Provide SPD unit designed, manufactured, tested and installed in compliance with the following codes and standards:

1. IEEE C62.41, C62.43, C62.45, C62.48, C62.62 Institute of Electrical and Electronic Engineers

2. NEMA LS-1 National Electrical Manufacturer Association

3. NFPA 20, 75 and 780 National Fire Protection Association

4. NFPA 70 National Electric Code

5. UL 1449 4th Edition or later, UL 1283 5th Edition or later and UL 96A Underwriters Laboratories

6. IEC 801 International Electrotechnical Commission

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 DEFINITIONS

A. TVSS - Transient Voltage Surge Suppression.

B. SAD - Silicon Avalanche Diode.

C. MOV - Metal Oxide Varistor.

D. SPD - Surge protective device.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

   a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

5. Submit independent test data from a nationally recognized testing laboratory verifying the following:

   a. Lifecycle testing
   b. Overcurrent protection
   c. UL 1449 4th Edition or later.
   d. Surge current capacity.

C. Shop Drawings:

1. Provide electrical and mechanical drawings by the manufacturer that detail:

   a. Unit dimensions.
   b. Weights.
   c. Components
   d. Field connection locations.
   e. Mounting provisions.
   f. Connection details.
   g. Wiring diagram.

D. Operation and Maintenance Manuals:

1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.7 COORDINATION

A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. One of the following or equal:

1. Liebert.
2. Eaton/Cutler Hammer.
3. Square D.
4. General Electric.

2.2 MANUFACTURED UNITS

A. Electrical Requirements

1. SPD ratings shall be consistent with the nominal system operating voltage, phase, and configuration.

2. Maximum Continuous Operating Voltage (MCOV):

a. The MCOV shall not be less than 115% of the nominal system operating voltage.

3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.

4. Unit shall operate without the need for an external overcurrent protection device (OCPD) and be listed by UL as such. Unit must not require external OCPD or replaceable internal OCPD for the UL Listing.

5. Operating Frequency:

a. 47 to 63 hertz.

6. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

B. Protection Modes:

1. Provide SPD protection modes as follows:

a. Line to Neutral (L-N).
b. Line to Ground (L-G).

c. Neutral to Ground (N-G).
d. Line to Line (L-L).

C. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

	Nominal Voltage	Configuration	L-N (Volts)	N-G (Volts)	L-G (Volts)	L-L (Volts)
Wye Models	120/208	Grounded Wye	700	700	700	1200
	277/480	Grounded Wye	1200	1200	1200	2000
	347/600	Grounded Wye	1500	1500	1500	3000

D. Environmental Requirements:

1. Storage Temperature:

   a. -40 degrees to +60 degrees Celsius.

2. Operating Temperature:

   a. 20 degrees to +60 Celsius.

3. Relative Humidity:

   a. 5 percent to 95 percent.

4. Audible Noise:

   a. Less than 45 dBa at 5 feet (1.5 m).

5. Operating Altitude:

   a. Zero to 12,000 feet above sea level.

E. Enclosure:

1. Located in electrical equipment where indicated on the Drawings.

F. Internal Connections:

1. Provide low impedance copper plates for intra-unit connections:

   a. Attach surge modules using bolted connections to the plates for low impedance connections.

2. Size all connections, conductors, and terminals for the specified surge current capacity.

2.3 COMPONENTS

A. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

B. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

C. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

1. Type 2 units with filtering shall conform to UL 1283 5th Edition.

2. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.

D. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

E. Thermal MOV Protection

1. The unit shall contain thermally protected MOVs. These self-protected MOVs shall have a thermal protection element integrated with the MOV and a mechanical disconnect with arc quenching capabilities in order to achieve overcurrent protection of the MOV. The thermal protection assembly shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

F. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. The use of plug in single-mode modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

G. Safety Requirements

1. The SPD shall minimize potential arc flash hazards by containing no single-mode plug in user serviceable / replaceable parts and shall not require periodic maintenance. SPDs containing items such as replaceable single-mode plug in

modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.4 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.

3. The panelboard shall be capable of re-energizing upon removal of the SPD.

4. The SPD shall be integral to the panelboard and connected directly to the bus. Alternately, an integral SPD can be connected to a circuit breaker for disconnecting purposes, in the case a disconnect is required.

5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.

6. The SPD shall be of the same manufacturer as the panelboard.

7. The complete panelboard including the SPD shall be UL67 listed.

2.6 SWITCHGEAR, SWITCHBOARD, MCC AND BUSWAY REQUIREMENTS

A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

B. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, or busway.

C. The SPD shall be factory installed integral to the switchgear, switchboard, MCC, and/or bus plug at the assembly plant by the original equipment manufacturer.

D. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

E. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

F. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.

G. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.7 SERVICE ENTRANCE REQUIREMENTS

A. Service entrance located SPDs shall be tested and designed for applications within ANSI/IEEE C62.41 Category C environments.

2.8 ACCESSORIES

A. Unit status indicators:

1. Provide red and green solid-state indicators, with printed labels, on the hinged front cover to redundantly indicate on-line unit status:

a. The absence of the green light and the presence of the red light indicates that surge protection is reduced and service is needed to restore full operation.

B. Dry contacts for remote monitoring:

1. Electrically isolated Form C dry contacts (10A/125VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide on-line circuit, which tests and redundantly monitors individual components in all protection modes including neutral to ground:

1. Units that require external test sets or equipment are unacceptable.

D. Provide an integral disconnect switch located in-line with the SPD system enclosure:

1. External manual operator.

2. The switch shall disconnect all ungrounded circuit conductors from the SPD.

3. The integral disconnect switch shall be capable of withstanding, without failure, the maximum published surge current magnitude and short circuit current without failure or damage to the switch.

E. Interconnection Cable:

1. Interconnect the SPD to the power system using a manufacturer furnished assembly of low impedance coaxial cables installed in flexible conduit.

2. Cable designed to transmit transients with minimal voltage drop.

3. UL listed.

2.9 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

B. Test the system at the component and fully assembled level, under surge conditions with alternating current power applied for a minimum of 1 hour:

1. Testing includes but not limited to:

a. Quality control checks.
b. Dielectric voltage withstand test per UL requirements.
c. UL ground continuity tests.
d. Operational and calibration tests.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Section 26 05 00.

B. Special Techniques:

1. Install the SPD with as short and straight conductors including ground conductor as practically possible.

2. Twist the SPD input conductors together to reduce input conductor inductance.

3. Follow the SPD manufacturer's recommended installation practices and comply with all applicable codes.

4. Interconnect the SPD to the power system using a manufacturer supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.

5. Do not subject SPD to insulation resistance testing.

END OF SECTION

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Abbreviations
3. Reference Standards
4. Quality Assurance
5. Submittals
6. Product Requirements
7. Installation
8. Testing

1.2 SCOPE

A. This Section includes the supply and installation of interior LED lighting fixtures and associated equipment.

1.3 ABBREVIATIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. ANSI C79.1, C81.61 – American National Standards Institute

C. NEMA LE 4 – National Electrical Manufacturer’s Association

D. NFPA 70 – National Electrical Code (NEC)

1.5 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. SPECIAL WARRANTY: The Special Warranty shall include as a minimum the following:

1. A written 5-year replacement material warranty forfixture finish and workmanship. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.

2. A written 5-year replacement material warranty for defective or non- starting LED source assemblies.

3. A written 5-year replacement material warranty on all power supply units (PSU).

4. A written 5-year replacement warranty for luminaires producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.

5. The warranty period shall begin on the date of Substantial Completion. The Contractor shall provide the Owner with appropriate signed warranty certificates. The Owner shall have received these certificates prior to final payment.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

E. Provide luminaires from a single manufacturer for each luminaire type.

F. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

    a. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the submitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

C. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

D. Product Data: Product Data: For each type of product.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

6. Photometric data and adjustment factors based on laboratory tests.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

E. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

F. Product Schedule: For luminaires and lamps.

G. Manufacturer's installation instructions.

H. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

2. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

I. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

2. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.

3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Bulb shape complying with ANSI C79.1.

F. Lamp base complying with ANSI C81.61 or IEC 60061-1.

G. CRI of minimum 80. CCT of 4000 K.

H. Rated lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 1 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: as specified on plans.

1. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.

L. Housings:

1. Refer to plans.

2.2 CYLINDER

A. Refer to plans for acceptable products.

B. With integral mounting provisions.

2.3 DOWNLIGHT

A. Refer to plans for acceptable products.

B. Universal mounting bracket.

C. Integral junction box with conduit fittings.

2.4 LINEAR INDUSTRIAL

A. Refer to plans for acceptable products.

2.5 RECESSED LINEAR

A. Refer to plans for acceptable products.

B. Integral junction box with conduit fittings.

2.6 STRIP LIGHT

A. Refer to plans for acceptable products.

B. Integral junction box with conduit fittings.

2.7 SURFACE MOUNT, LINEAR

A. Refer to plans for acceptable products.

B. Integral junction box with conduit fittings.

2.8 SURFACE MOUNT, NONLINEAR

A. Refer to plans for acceptable products.

B. Integral junction box with conduit fittings.

2.9 SUSPENDED, NONLINEAR

A. Refer to plans for acceptable products.

B. Integral junction box with conduit fittings.

2.10 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.

2. See plans for finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.

b. Lamp diameter, shape, size, wattage, and coating.

c. CCT and CRI for all luminaires.

2.11 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.12 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12-gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and relamping.

3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.

2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.

3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120-inches (6m) in length.

2. Ceiling mount with pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.

3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.

2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 26 05 19 "Low-Voltage Conductors, Wires and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 26 08 00 Commissioning of Electrical Systems.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.

2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3. Adjust the aim of luminaires in the presence of the engineer.

END OF SECTION

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SECTION 26 52 13.16 - EXIT SIGNS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Products
6. Execution

1.2 SCOPE

A. The extent of lighting fixture work is as shown and scheduled, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.

1.3 REFERENCE STANDARDS

A. NFPA 101 – National Fire Protection Association

B. DOE LT-4 – US Department of Energy

C. OSNA 29 CFR 1910 – Occupational Safety and Health Standards

D. UL 924 – Underwriter Laboratories

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. The manufacturer shall warranty the above specified equipment for five years from equipment start-up to be free from defects in design, workmanship or materials. Including but not limited to LED’s, driver, back-up batteries, and housing.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

    a. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

C. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

D. Submit exit lighting units outline drawings indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment.

E. Submit certificates clearly indicating the energy efficiencies of each fixture type.

F. Submit copy of warranty in compliance with above requirements.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide emergency exit lighting fixtures conforming to UL 924, NFPA 101, and as specified.

B. Provide exit lighting fixtures completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Ensure ceiling-mounted fixtures are designed to be supported independent of the ceiling and equipped with lamps.

C. Provide exit lighting fixtures having efficiencies in accordance with the recommended levels specified in DOE LT-4.

2.2 COMPONENTS

A. Emergency Power Loss Exit Lighting Units

1. Provide each self-contained unit with an automatic power failure device, test switch, pilot light, and fully automatic high/low solid-state trickle charger in a self-contained power pack. Provide with gelled-electrolyte type battery, maintenance-free for a period of not less than 5-years under normal operating conditions. Ensure normal operation is with 120-277volts.

B. Light Emitting Diodes (LEDs) Exit Lighting Fixtures

1. Provide single or double] faced exit lighting fixtures with sheet metal enclosures, including frames, battery charger, batteries, red or green light emitting diodes (LEDs), and mounting brackets with mounting plates suitable for securing the fixture to a 100 millimeter 4-inch outlet box. Ensure fixture features include:

a. Continuous charging

b. Automatic switching to standby batteries upon loss of power

c. Overload protection

d. Short circuit protection

e. Test switch

f. Low voltage disconnect

g. Switch controlled left and right LED directional arrows

h. Field connectable to operate from 115-277 volts

i. Brightness not less than ten (10) candela candlepower

2. Provide unit battery system with minimum operating time of three (3) hours for double faced fixtures and seven (7) hours for single faced fixtures.

C. Self-Luminous Exit Signs

1. Provide internally illuminated non-electric (light source is independent of electrical power and is generated by the action of tritium gas on a phosphorescent material) units, conforming to UL 924, 29 CFR 1910, Section 37, Part (G), Subparts (6) and (7), and NFPA 101, Section 5-10.3.3. Ensure signs are licensed by the United States Nuclear Regulatory Commission with a 20-year normal use guarantee for integrity and performance.

a. Enclosure

1) Provide units with 1/8-inch-high impact ABS plastic 0.20-inch thickness metal, assembled tamperproof enclosure, framed with 1.3-millimeter-thick extruded aluminum.

2) Ensure each sign has a permanently attached nameplate bearing the Manufacturer's Name and Address and Date of Manufacture (in addition to information required by listed authorities.)

b. Face

1) Ensure each face of the sign has a non-colored translucent panel covered by an opaque 1/8-inch red ABS plastic stencil bearing the word "EXIT" in 6 by 3/4-inch letters and including a universal directional arrow which indicates the direction of the exit (left, right or both ways).

c. Illumination

1) Provide sign which has illumination by means of sealed glass tubes, internally phosphor coated and filled with tritium gas, with tubes securely bonded to the enclosure and cushioned against mechanical shock. Ensure luminous areas have a minimum initial brightness of 0.15-foot lamberts and a guaranteed minimum brightness after ten years of 0.080-foot lamberts.

d. Mounting Accessories

1) Supply each sign with tamperproof hardware for wall mounting; edge on for double face, flat for single face or double face for ceiling mount.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Tests

1. Field test exit lighting to demonstrate satisfactory operation in the presence of the Engineer.

2. Perform and submit operational tests in accordance with referenced standards in this section.

END OF SECTION

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SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Definitions
5. Structural Analysis Criteria for Pole Selection
6. Submittals
7. Product Requirements
8. Installation

1.2 SCOPE

A. This specification covers the furnishing and installation of poles and materials for exterior lighting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations.

B. Section Includes:

1. Poles and accessories.

2. Luminaire lowering devices.

1.3 REFERENCE STANDARDS

A. AASHTO LTS-4-M American Association of State Highway and Transportation Officials

B. ASTM B 660 American Society for Testing and Materials

C. NFPA 70 National Electrical Code

D. NFPA 70E National Electrical Safety Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. Special Warranty for Poles and Pole Hardware: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects

of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

2. Warranty Period for Color Retention: Five years from date of Substantial Completion.

3. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.5 DEFINITIONS

A. Luminaire: Complete lighting fixture, including ballast housing if provided.

B. Pole: Luminaire support structure, including tower used for large area illumination.

C. Standard: Same definition as "Pole" above.

1.6 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 100 mph (45 m/s) OR 90 mph (40 m/s), as directed.

   a. Wind Importance Factor: 1.0.

   b. Minimum Design Life: 50 years.

   c. Velocity Conversion Factors: 1.0

2. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) OR 90 mph (40 m/s).

a. Wind Importance Factor: 1.0.

b. Minimum Design Life: 25 years.

c. Velocity Conversion Factors: 1.0.

1.7 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

   a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

a. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

C. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

D. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

5. Anchor bolts for poles.

6. Manufactured pole foundations.

E. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

F. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

G. Operation and Maintenance Data: For poles OR luminaire lowering devices, as directed, to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.2 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Round, tapered OR Round, straight OR Square, tapered OR Square, straight, as directed.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm OR Truss OR Davit, as directed, type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless OR galvanized, as directed, -steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.

3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

G. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

K. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

L. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As indicated by manufacturer's designations OR As selected from manufacturer's full range, as directed.

2.3 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.

1. Shape: Round, tapered OR Round, straight OR Square, tapered OR Square, straight, as directed.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems",

listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.

2. Finish: Same as pole OR luminaire, as directed.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: Light bronze OR Medium bronze OR Dark bronze OR Black OR As selected from manufacturer's full range, as directed.

2.4 FIBERGLASS POLES

A. Poles: Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole. Not less than 65 percent fiberglass, with resin and pigment making up the remainder.

1. Resin Color: Dark bronze; provide uniform coloration throughout entire wall thickness.

2. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils (0.04 mm). Polyurethane may be omitted if the surface layer of pole is inherently UV inhibited.

2.5 DECORATIVE POLES

A. Pole Material:

1. Cast ductile iron

2. Cast gray iron, according to ASTM A 48/A 48M, Class 30.

3. Cast aluminum

4. Cast concrete

5. Spun concrete

6. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.

B. Mounting Provisions:

1. Bolted to concrete foundation.

2. Embedded

C. Fixture Brackets:

1. Cast ductile iron

2. Cast gray iron

3. Cast aluminum

D. Pole Finish: Matt Black

2.6 LAMINATED WOOD POLES

A. Species and Grades for Structural Glulam Timber: Engineer and fabricate structural laminated wood poles, complying with ANSI A190.1. Use southern pine OR Douglas fir OR Alaska cedar OR any species listed in AITC 117, as directed, to withstand indicated structural loads without exceeding allowable design working stresses according to AITC 117.

B. Features: Include wood bracket OR wood crossarm OR pole-top adapter, as directed, for mounting luminaire(s), metal pole cap, as directed, and concealed raceway path connected to access handhole.

C. Mounting Provisions: Embedded.

D. Appearance Grade: Architectural appearance grade complying with AITC 110.

E. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for waterborne preservatives. After dressing and end-cutting each member to final size and shape, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.6 mm).

F. Adhesive: Wet-use type complying with ASTM D 2559.

G. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

H. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

I. Finish: Natural, unstained wood OR Semitransparent stain applied after erection OR Semitransparent stain applied at factory, as directed, color as selected.

2.7 WOOD POLES

A. Poles: Douglas fir OR Southern yellow pine, as directed, machine trimmed by turning, as directed, complying with ANSI O5.1 and with AWPA C4 for wood species used; and bored, roofed, and gained before treatment.

1. Mounting Provisions: Embedded.

B. Preservative Treatment: Pressure treat poles with creosote OR pentachlorophenol OR ammoniacal copper arsenate, as directed, according to AWPA C1 and AWPA C4.

C. Luminaire Brackets: Comply with ANSI C136.13.

2.8 PRESTRESSED CONCRETE POLES

A. Poles: Manufactured by centrifugal spin-casting process OR of cast concrete, as directed.

1. Shape: Round, tapered OR Round, straight OR Square, tapered OR Square, straight, as directed.

2. Mounting Provisions: Steel butt flange for bolted mounting to foundation or breakaway support OR Embedded, as directed.

3. Finishing: Capped at top and plugged at bottom. Seat each steel reinforcing strand with epoxy adhesive.

4. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch (610-mm) lightning rod, as directed.

B. Cure with wet steam and age for a minimum of 15 days before installation.

C. Fabricate poles with a hard, nonporous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.

D. Cast aluminum nameplate into pole wall at approximately 5 feet (1.5 m) above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.

E. Pole Brackets: Comply with ANSI C136.13.

F. Finish Color: Provided by color material complying with ASTM C 979, uniformly impregnated throughout the pole concrete. Color material shall provide a uniform, stable, permanent color and be as follows:

1. Inert, and carbon free.

2. Unaffected by environmental conditions and contaminants including, but not limited to, UV solar radiation, salts, and alkalis.

G. Finish Texture: Standard form OR Polished exposed aggregate OR Etched exposed aggregate, as directed.

1. Exposed aggregate shall be Owner’s choice.

2.9 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Surface mounted OR Recessed, as directed, 12 inches (300 mm) above finished grade.

2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R OR Type 4X, as directed, enclosure.

3. With cord opening.

4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) OR indicated accessories, as directed.

E. Decorative accessories, supplied by decorative pole manufacturer, include the following:

1. Banner Arms: Aluminum.

2. Flag Holders: Cast Brass.

3. Ladder Rests: Cast Brass.

2.10 LOWERING SYSTEM FOR LUMINAIRES

A. Arrange system to lower luminaire OR luminaire assembly, as directed, to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.

B. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.

C. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.

D. Luminaire Mounting and Disconnect Arrangement: Multiple ring OR carriage, as directed, mounted luminaires, arranged for lowering and rising as a group.

1. Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.

E. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit

that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to Owner or authorities having jurisdiction.

F. Lowering Cable: Zinc-electroplated- or stainless-steel aircraft cable.

G. Portable Winch: Manual OR 120-V electric, as directed, type. One required.

1. Winch Power Connection: Cord and plug.

2. Winch Raise-Lower Control: Remote-control station with 15 feet (5 m) of cable.

H. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

PART 3 EXECUTION

3.1 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).

3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-place Concrete".

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers unless otherwise indicated.

4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.

2. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augured holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.

2. Fill augured hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.

3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.

4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

H. Raise and set poles using web fabric slings (not chain or cable).

3.2 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete”.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRS

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth.

Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways, Boxes, & Fittings". In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

A. Ground metal poles and support structures:

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures:

1. Install grounding electrode for each pole.

2. Install grounding conductor and conductor protector.

3. Ground metallic components of pole accessories and foundations.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION

SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Abbreviations
3. Reference Standards
4. Quality Assurance
5. Submittals
6. Product Requirements
7. Installation
8. Testing

1.2 SCOPE

A. The extent and location of “Exterior Lighting” Work is shown in the Contract Documents. This section includes exterior luminaires and accessories.

B. Definitions:

1. Luminaire (Light Fixture): A complete lighting device consisting of LEDs and drivers, when applicable, together with parts designed to distribute light and to connect to power supply.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code

B. NFPA 70E – National Electrical Safety Code

C. NFPA 101 - Life Safety Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 26 05 00 General Requirements for Electrical Work

B. SPECIAL WARRANTY: The Special Warranty shall include as a minimum the following:

1. A written 5-year on-site replacement material, fixture finish and workmanship. On-site replacement includes transportation, removal, and installation of new products. Finish warranty must include warranty against failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.

2. A written 5-year replacement material warranty for defective or non- starting LED source assemblies.

3. A written 5-year replacement material warranty on all power supply units (PSU).

4. A written 5-year replacement warranty for luminaires producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.

5. The warranty period shall begin on the date of Substantial Completion. The Contractor shall provide the Owner with appropriate signed warranty certificates. The Owner shall have received these certificates prior to final payment.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

E. Provide luminaires from a single manufacturer for each luminaire type.

F. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall

list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

a. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

C. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

D. Submittals shall include the following:

1. Plan: Provide layout and details of exterior lighting assemblies, including relevant information about supporting structure and supported lighting system. Show structural and electrical attachment locations, methods, and components.

2. Product Data: For each type of luminaire indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

a. Materials and dimensions of luminaire, including Effective Projected Area.

b. Luminaire materials.

c. Photoelectric relays.

d. Drivers, including energy-efficiency data.

e. LED's, including life, output, CCT, CRI, lumens, and energy-efficiency data.

f. Certified results of laboratory tests for luminaire photometric performance.

3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.

a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers

1. LED Lamps

a. Cree

b. Philips

c. Or Approved Equal.

2. LED Drivers

a. Cree

b. Philips

c. Or Approved Equal.

B. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products indicated in the Lighting Fixture Schedule located on the Drawings.

2.2 LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, anchorage and foundation.

C. Wind Load Strength of Support Assembly: Wind load strength of support assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mph (160 km/h) with a gust factor of 1.3.

D. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

E. Metal Parts: Corrosion resistant aluminum, free from burrs, sharp corners, and edges.

F. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

H. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens.

I. Exposed Hardware Material: Stainless steel.

J. Hangers for pendant fixtures are to be rigid type; with not less than five-threaded engagement turns at each end. A safety factor of 4 shall be used in sizing anchors and hangers.

K. Light Shields, where required: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

L. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

M. Reflecting Surfaces: which are painted shall be baked white enamel or manufacturer standard color, two coats minimum with an average reflectance of 90% or greater.

N. Lenses, Diffusers, Covers, and Globes; High resistance to yellowing and other changes due to aging, UV stabilized. 100% virgin acrylic plastic or annealed crystal glass.

O. Lenses and Refractors Gaskets: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

P. Luminaire Finish: Painted parts shall be water-based coatings and shall be low VOC. Manufacturer's standard paint applied to factory-assembled and -tested luminaire

before shipping. Where indicated, match finish process, and color of pole or support materials.

Q. Photoelectric Relays: As follows:

1. Contact Relays: Single throw, arranged to fail in the on position and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.

2. Relay Mounting: In luminaire housing.

R. Provide thermal protection.

S. Provide a scope mounting for each fixture and one aiming scope for aiming of all floodlight fixtures.

T. Lighting design is the primary element of an electrical design that affects system efficiency. Evaluate available lighting fixtures on a life cycle cost basis to determine the most appropriate technology for each application.

U. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

2.3 LED DRIVERS

A. Class 1, constant current.

B. Power factor >90% at full load.

C. THD <20%.

D. Integral surge protection in accordance with ANSI C62.41.2.

E. Minimum 5-year warranty.

2.4 LED LAMPS

A. Color temperature range from 3500K – 5500K based on specific project parameters.

B. CRI >80.

C. Lumens per watt >80.

D. Minimum 70,000-hour life at above 70% rated light output.

PART 3 EXECUTIOIN

3.1 INSTALLATION

A. Luminaire Attachment: Comply with luminaire manufacturer's mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated. Fasten to indicated structural supports.

1. Fixture shall be level, in straight lines, aligned, and coordinated with ceiling construction and other trades.

2. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Provide fuses mounted in fuse holder. Where fixed fuse holder is not provided standard by manufacturer, provide in-line fuse holder such as Bussmann HFB, Littelfuse, Or Approved Equal, accessible through standard handhole and furnish with enough slack wire to extract the fuse holder for servicing.

C. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 - Identification for Electrical Systems.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of luminaires after installing and energizing circuits with normal power source, and as follows:

1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standard SP-250 or other relevant NIST publication.

2. Check intensity and uniformity of illumination.

E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.5 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust amiable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities.

3.6 EXTERIOR LUMINAIRE FIXTURE SCHEDULE

A. Refer to Fixture Schedule on the Drawings.

END OF SECTION

SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.

B. Section includes:

1. Subsoil materials

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials source.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Owner’s Representative.

2. Frequency of testing shall be determined by the Owner's Representative.

3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Owner's Representative.

2. Graded.

3. Free of peat, humus, vegetative matter, organic matter, and rocks larger than 6 inches in diameter.

4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, General Imported Structural Fill Material:

1. Imported earth approved for use by Owner's Representative.
2. Well graded sand or sand and gravel mixture.
3. Less than 10 percent fines.

2.2 TREATMENT ZONE SOIL

A. Soil with an infiltration rate between 0.25 and 0.50 in/hr.

B. Organic material content shall be at least 2% by weight.

C. Average cation exchange capacity (CEC) must be at least 15 milliequivalents per 100 grams.

2.3 SPOILS

A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Owner's Representative or stockpiled onsite as indicated on the Drawings.

B. Make arrangements for disposal of the material at no additional cost to the Owner.

C. Landfill permit to be obtained by the Contractor and provided to Owner's Representative prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698 (AASHTO T99).

B. When tests indicate materials do not meet specified requirements, change material, or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

C. Furnish materials of each type from same source throughout the Work.

D. The Owner or Owner's Representative may elect to perform a swale flood test or single ring infiltration test to assess the infiltration rate of the treatment zone soil. If test results do not meet these criteria, the Contractor shall amend or replace the treatment zone soil at no cost to the Owner.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.

B. When practical, do not excavate wet topsoil.

C. Stockpile excavated material as indicated on the drawings.

3.2 STOCKPILING

A. Stockpile soils at locations shown in the Drawings or at locations as approved by Owner's Representative for redistribution as specified.

1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the Project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.

2. No additional payments will be made for stockpiling excavated materials off-site.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile unless otherwise noted on the Drawings, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes a range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.

B. Section Includes:

1. Coarse aggregate materials
2. Fine aggregate materials

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses

2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates

3. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)

4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Aggregate Testing:

1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Engineer.

2. The frequency of testing shall be determined by the Engineer.

3. All aggregate testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).

2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Imported Structural Fill, Type A1, Dense-Graded Aggregate: Crushed rock with ¾-inch-0, 1-inch-0, 1-1/2-inch-0, 2-inch-0 and 2-1/2-inch-0 gradation as shown in the Drawings and meeting the requirements provided below.

1. Grading - Dense-graded base aggregate shall be crushed rock, including sand. Uniformly grade the aggregates from coarse to fine.

2. Sieve analysis shall be determined according to AASHTO T27.

3. The aggregates shall conform to one of the grading requirements Table 31 05 16-A below.

Table 31 05 16-A
Grading Requirements for Dense-Graded Aggregate
Separated Sizes
Percent Passing (by weight)

Sieve Size	2-1/2" - 0	2" - 0	1-1/2" - 0	1" - 0	3/4" - 0
3”	100				
2-1/2”	95 - 100	100			
2”	-	95 - 100	100		
1-1/2"	-	-	95 - 100	100	
1-1/4”	55 - 75	-	-	-	
1”	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8”	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4*	-	-	-	-	-
No. 10	[1]	[1]	[1]	[1]	[1]

[1] Of the fraction passing the 1/4-inch sieve, 40 percent to 60 percent shall pass the No. 10 sieve.
* Report percent passing sieve when no grading requirements are listed.

4. Fracture of Rounded Rock:

   a. Determined according to AASHTO TP61.

   b. Provide at least one fractured face based on the following percentage of particles retained on the 1/4-inch sieve for the designated size:

Minimum Percent of Fractured Particles
by Weight of Material

Designated Size	Retained on 1/4-Inch Sieve
1-1/2-inch – 0 and larger	50
Smaller than 1-1/2-inch – 0	70

5. Durability:

   a. Crushed rock aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0 percent maximum
Degradation (Coarse Aggregate)	ODOT TM 208	30.0 percent maximum
Passing No. 20 Sieve, Sediment Height	ODOT TM 208	3.0-inch maximum

6. Sand Equivalent -- Crushed rock aggregate will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 50.

B. Coarse Aggregate Type A2, Granular Drain Backfill Material: Crushed or uncrushed rock or gravel as shown in the Drawings.

1. Material shall be clean and free draining.
2. Sieve analysis shall be according to AASHTO T27.
3. Grading: Meeting the gradation requirements provided in Table 31 05 16-B below.

Table 31 05 16-B
Grading Requirements for Granular Drain Backfill Material
Separated Sizes
Percent Passing (by weight)

Sieve Size	Separated Sizes 1-1/2-inch – 3/4-inch	Separated Sizes 3/4-inch – 1/2-inch
2-inch	100	
1-1/2-inch	90 - 100	
1-inch	20 - 55	100
3/4-inch	0 - 15	85 - 100
1/2-inch	-	0 - 15
3/8-inch	0 - 5	-

2.2 SAND

A. Sand: Sand material shall consist of granular material, naturally produced, or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash, and other deleterious material, meeting the gradations of Table 31 05 16-C below.

Table 31 05 16-C
Grading Requirements for Sand
Separated Sizes
Percent Passing (by weight)

Sieve Size	Coarse Sand	Medium Sand	Fine Sand
1-inch	100	100	100
3/8-inch	95 - 100	95 - 100	-
#4	80 - 100	70 - 95	90 - 100
#30	10 - 30	10 - 45	-
#100	-	2 - 10	2 - 10
#200	0 - 8	0 - 7	0 - 4
Sand Equivalent	50 min.	50 min.	50 in.

2.3 RIPRAP

A. General - Furnish rock for loose riprap meeting the following requirements:

1. Meet the test requirements of provided herein.

2. Be angular in shape. Thickness of a single rock shall not be less than 1/3 its length. Rounded rock will not be accepted unless authorized by the Engineer.

3. Meet the gradation requirements for the class specified.

4. Be free from overburden, spoil, shale, and organic material. Non-durable rock, shale, or rock with shale seams is not acceptable.

B. Gradation Requirements - Grade loose riprap by class and weight of rock according to the following:

Class 50	Class 100	Class 200	Class 700	Class 2000	
Weight of Rock (pounds)					Percent (by Weight)
50 - 30	100 - 60	200 -	700 -	2000 -	20.0
30 - 15	60 - 25	140	500	1400	30.0
15 - 2	25 - 2	140 - 80	500 -	1400 -	40.0
2 - 0	2 - 0	80 - 8	200	700	10.0 - 0
		8 - 0	200 - 20	700 - 40	
			20 - 0	40 - 0	

Uniformly grade each load of riprap from the smallest to the largest weight specified. Control of gradation will be by visual inspection.

1. Control Sample - If directed, provide, at a satisfactory location near the Project Site, a rock sample of at least 5 tons meeting the gradation for the class specified. This sample will be used as a frequent visual reference for judging the gradation of the riprap supplied.

2. Sampling and Testing Assistance - Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two random truckloads of rock. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

2.4 SOURCE QUALITY CONTROL

A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698 (AASHTO T99).

B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D698 (AASHTO T99).

C. Riprap – Furnish the rock meeting the following test requirements:

Material Test	Requirement
Apparent Specific Gravity (AASHTO T 85)	2.50 Min.
% Absorption (AASHTO T 85)	6.0 Max.
Degradation (ODOT TM 208A)	
Passing No. 20 Sieve	35.0% Max.
Sediment Height	8.0" Max.
Soundness (AASHTO T 104)	
Average Loss of 2 1/2" - 1 1/2" and	
1 1/2" - 3/4" fraction after 5	16.0% Max.
alternations	

D. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials imported to site at locations as approved by the Owner for redistribution as specified.

B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

C. Prevent intermixing of aggregate types or contamination.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes clearing site of incidental debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Limits of Disturbance: Work area boundary as shown on the Plans.

E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.

F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.

C. Certification or disposal permit for landfill and/or waste disposal site.

D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.4 QUALITY ASSURANCE

A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.

B. Obtain Owner’s Representative’s approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.

C. Conform to applicable local, state, and federal codes for environmental requirements and disposal of debris,

1. Burning on Project Site will not be permitted.
2. Use of herbicides will not be permitted.

D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.

E. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.

B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements shown on drawings.

B. Remain within the property lines at all times.

C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

A. Verify existing plant life designated to remain is tagged or identified.
B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

A. Carefully coordinate the work of this Section with all other work and construction.

B. Call Local Utility Line Information service at 1-800-332-2344, not less than three working days before performing Work.

C. Request underground utilities to be located and marked within and surrounding construction areas.

1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.

2. Keep all active utilities intact and in continuous operations.

D. Prepare Site only after:

1. Erosion and sediment controls are in place.

a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.

2. Tree and vegetation protection is installed.

a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.

3. Temporary fencing is installed along the project limits as shown in the drawings.

4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 PROTECTION

A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.

B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs, and Other Vegetation:

1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.

2. Protect existing trees and shrubs against cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction

materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.

3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.

4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out, cover with earth as soon as possible.

5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.

6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Owner's Representative. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.

2. Conduct Work in a manner that will restore original conditions as nearly as practicable.

3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.

4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.

5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.

6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.

E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, and curbs.

F. Repair and Replacement:

1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.

2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.5 LIMITS

A. As follows, but not to extend beyond Limits of Disturbance as shown on the Drawings.

1. Booster Station site: Extents shown in Drawings, extending 5 feet beyond top of cut slopes.

2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.

3. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling is permitted in area(s) shown on Drawings and as provided by the Owner.

3.6 CLEARING AND GRUBBING

A. Clear and grub areas within limits shown on drawings.

B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.

C. Clearing:

1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except those trees and shrubs noted to remain in the Drawings or as directed by the Owner's Representative.

2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the Project Site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.

3. Clear undergrowth and deadwood, without disturbing subsoil.

D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to a minimum depth of 6-inches.

3.7 TREE REMOVAL

A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.

B. Tree Salvage: As shown on the Plans.

C. No trees may be removed unless approved and permitted by the Owner's Representative.

D. Do not top trees unless otherwise specified or approved by Owner in writing.

3.8 REMOVAL AND DISPOSAL

A. Native vegetation may be mulched and used on Site.

B. Asphalt and Gravel Surfaces:

1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.

2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Owner's Representative.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.

C. Remove debris, rock, abandoned piping, and extracted plant life from Site.

D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.

1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the Work.

2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.

G. Removal: All material resulting from demolition, clearing, and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.

I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.

B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.

C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Owner's Representative.

D. The Work will not be considered complete, or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Owner's Representative.

END OF SECTION

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SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.

B. Section Includes:

1. Excavating topsoil
2. Excavating subsoil
3. Cutting, grading, filling, and rough contouring of Site

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.

C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS

2.1 MATERIALS

A. Subsoil Fill: Type S1 and S2 as specified in Section 31 05 13, Soils for Earthwork.

B. Treatment Zone Soil as specified in Section 31 05 13, Soils for Earthwork.

C. Imported Structural Fill: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

D. Granular Fill:

1. Type A2, Granular Drain Backfill Material as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than 3 working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Notify Owner’s Representative of any potential conflicts resulting from utility locations and the Drawings.

3. Notify utility company to remove and relocate utilities, as may be necessary.

B. Identify required lines, levels, contours, and datum.

C. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with the Work of this Section.

3.3 TOPSOIL EXCAVATION

A. Excavate and stockpile topsoil as specified in Section 31 05 13, Soils for Earthwork.

3.4 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.

B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.

C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.

D. When excavating through roots, perform Work by hand and cut roots with sharp axe.

E. Benching Slopes: Horizontally bench existing slopes greater than or equal to 1:5 to key placed fill material to slope to provide firm bearing.

F. Stability: Replace damaged or displaced subsoil as specified for fill.

3.5 FILLING

A. Place material per Section 31 23 23, Fill.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

3.7 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D2922
2. Moisture Tests: ASTM D3017

C. Frequency and location of testing is dependent upon type of material placed. See Section 01 45 00, Quality Control for testing requirements.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

END OF SECTION

SECTION 31 23 16 – EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.

B. Section Includes:

1. Excavating for building foundations
2. Excavating for paving, roads, and parking areas
3. Excavating for slabs-on-grade
4. Excavating for site structures
5. Excavating for landscaping

1.2 DEFINITIONS

A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation.

B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, as defined below.

C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.

D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.

F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory

excavation, for the purposes of locating an underground utility and to investigate underground conditions.

G. Rock: Solid mineral material, including boulders, solid bedrock, or ledge rock, with volume in excess of 1/2 cubic yard or solid material which, by actual demonstration, cannot be reasonably excavated with suitable machinery as defined herein. The Owner's Representative may waive the requirements for actual demonstration if the material encountered is well-defined rock.

H. Rock Removal: Removal of rock as defined herein by systematic and continuous drilling, hammering, breaking, splitting, or other methods approved by the Owner's Representative.

I. Suitable Machinery:

1. A track-mounted hydraulic excavator of the 52,800- to 72,500-pound class equipped with a single shank ripper.

2. A track-mounted rocksaw trencher capable of a minimum trenching depth of 4 feet.

J. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.

K. Unsuitable Materials: See Spoils.

1.3 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

B. Provide adequate survey control to avoid unauthorized over-excavation.

C. Weather Limitations:

1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (F) shall not be used as fill or backfill until material completely thaws.

2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.6 NOT USED

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Owner's Representative as to the nature and extent of the differing conditions.

B. Call Local Utility Line Information service at 1-800-332-2344 not less than 3 working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

C. Identify required lines, levels, contours, and datum.

D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Owner's Representative to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 EXISTING UNDERGROUND UTILITIES

A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.

B. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:

1. General:

   a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.

   b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1-foot beyond the outside walls of the abandoned manhole, sump, or basin.

   c. Plug all abandoned pipes with permanent plugs as specified in Section 33 05 50, Existing Pipe Abandonment.

2. Sumps:

   a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.

   b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

   c. Fill sump with CLSM.

   d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.

3. Salvaging Manhole Frames, Covers, and Grates:

   a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.

   b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.

   c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.

   d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.

4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Owner's Representative a

minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.4 PRESERVATION OF EXISTING IMPROVEMENT

A. Protect adjacent existing structures which may be damaged by excavation work.

1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.

2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Owner's Representative.

3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Owner's Representative

4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.5 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor's option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Owner's Representative at no additional cost to Owner.

3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.

4. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.

2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.

3. Grade top perimeter of excavation to prevent surface water from draining into excavation.

4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil, and similar items, wherever applicable.

2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

a. Subsoil Type S1, Select Native Fill, as approved for use by Owner's Representative.

2. Spoils:

a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.

b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.

c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Owner's Representative.

F. Shoring:

1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state, and federal laws, codes, and ordinances.

2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain, and remove such supports in accordance with applicable ordinances and safety requirements.

3. The design, planning, installation, and removal of all sheeting accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

2. Protection of excavation side slopes:

a. Use excavation methods that will not shatter or loosen excavation slopes.

b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.

c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.

d. Excavation in rock or rocky cuts:

1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.

2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.

3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.

e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.

3. Construct slopes free of all exposed roots.

4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.

5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

6. Trim all surfaces neatly and smoothly.

H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.

I. Notify Owner's Representative of unexpected subsurface conditions.

J. Over-excavation for Unsuitable Foundation Conditions: As shown on the drawings.

K. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.6 FIELD QUALITY CONTROL

A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.

B. Coordinate the visual inspection and approval of all bearing surfaces by Owner's Representative before installing subsequent work.

3.7 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.

B. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, trench backfill, and related Work as shown on the Drawings and as specified.

B. Section includes:

1. Excavating trenches for pipe, utility vaults, and other utilities.
2. Compacted fill from top of utility bedding to final grades.
3. Trench and utility vault backfilling and compaction.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

5. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.3 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill. Lean cement concrete fill. A self-compacting, cementitious material.

B. Flexible Pipe: For the purposes of these Specifications, tubing between 1/2-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.

C. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.

D. Imported Material: Materials obtained from sources offsite, suitable for specified use.

E. Lift: Loose (uncompacted) layer of material.

F. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.

G. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

H. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable, or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

I. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable, or duct bank.

J. Pipe Bedding, Pipe Zone, and Trench Backfill Classifications:

1. Class A: Backfill with material meeting the requirements of Subsoil Fill Type S1 or S2 as specified in Section 31 05 13 Soils for Earthwork.

2. Class B: Backfill with material meeting the requirements of this Section and Imported Structural Fill, Type A1 as specified in Section 31 05 16, Aggregates for Earthwork; typical designated size shall 3/4-inch-0.

3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.

4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.

5. Class E: Backfill with CLSM. See Section 31 23 24, Flowable Fill.

K. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.

L. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie, and which provides support for the pipe.

M. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.

N. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete, and clay pipes are considered rigid pipes.

O. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.

P. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface, or other surface material.

Q. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.

R. Utility: Any buried pipe, duct, conduit, or cable.

S. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: At a minimum, to include the following:

1. Methods and sequencing of mass excavation.

2. Proposed on-site and off-site spoil disposal locations.

3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner’s access to Owner’s facilities impacted by excavation Work.

5. Proposed haul routes.

C. Product Data:

1. Geotextile fabric, indicating fabric and construction
2. Tracer wire
3. Connectors for tracer wire and/or marking tapes
4. Tracer wire locate boxes

D. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

E. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

F. Concrete: Mix designs in accordance with Submittal requirements of Section 03 30 00, Cast-in-Place Concrete.

1.5 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.6 NOT USED

1.7 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1 and S2 as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Structural Fill: Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).

2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete with compressive strength of 3,000 psi.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.

F. Trench Stabilization Material: Imported Structural Fill, Type A1, Dense-Graded Aggregate, 3/4-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 NOT USED

2.3 ELECTRONIC LOCATING MATERIALS

A. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.

2. Tensile Breaking Load: 380-pound average.

3. Jacket:

a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.

b. Color: Provide in colors per Article 2.03.B above.

4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or equal.

B. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.

2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.

3. Lug Connectors:

a. Waterproof plastic housing that encases the silicone prefilled lug terminals.

b. Manufacturer and Product: King Innovations; DryConnTM Direct Bury Lug or equal.

4. Twist Connectors:

a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.

b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors or equal.

C. Ground Wire: No. 12 AWG bare solid copper wire.

2.4 NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Call Local Utility Line Information service at 1-800-332-2344 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.

3. Maintain and protect above and below grade utilities indicated to remain.

B. Identify required lines, levels, contours, and datum locations.

C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.

E. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.

F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.

G. Paved or Surfaced Streets:

1. Wherever paved or surfaced streets are cut, saw wheel, or approved cutting devices shall be used.

2. Width of pavement cut shall be as shown in the Drawings.

3. Any cut or broken pavement shall be removed from site during excavation.

H. Traffic:

1. Maintain street traffic at all times as required by the Drawings and as specified herein.

2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.

3. Provide flaggers as required during active work in roadway areas.

I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Owner's Representative.

3.2 EASEMENTS

A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.

B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.

C. Confine construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required and notify the Owner's Representative with a copy of the written approval from property owners of any such conditions.

D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Owner's Representative will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

A. Existing Facilities:

1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.

2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Owner's Representative.

3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.

B. Removal of Water:

1. As specified in Section 31 23 19, Dewatering.

2. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.

3. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.

4. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.

C. Trench Protection:

1. Provide the materials, labor, and equipment necessary to protect trenches at all times.

2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.

3. The method of protection shall be according to the Contractor's design.

4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets the approval of all applicable local, state, and federal safety codes.

5. Damages resulting from improper shoring, improper removal of shoring, or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

A. Trench excavation for piping, utility vaults, and other utilities shall be performed to the alignment and grade as indicated in the Drawings.

B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.

C. Water mains shall be installed with a minimum cover of 36 inches.

D. The Owner's Representative reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.

2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.

F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.

B. The Owner's Representative may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.

1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.

B. Paved Roadways:

1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.

2. New pavement shall be equal to or better than the existing paved surface.

3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.

C. Existing Structures:

1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Owner's Representative before continuing with the Work.

2. The Owner's Representative may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.

3. The cost of waiting or “down time” during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Owner’s Representative.

4. If the Contactor fails to so notify the Owner’s Representative when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor’s own risk with no additional payment.

3.7 TRENCHING

A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.

B. Open Trench Limit:

1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.

2. A maximum length of open trench shall not exceed 100 feet at any one time.

3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.

4. Cover or backfill excavations at the end of each day.

5. If the trench is not backfilled at the end of each working day:

a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.

b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.

c. Provide signed and stamped submittal of caving prevention system and cover system.

6. New trenching shall not be started when earlier trenches need backfilling, or the surfaces of streets or other areas need to be restored to a safe and proper condition.

C. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility’s requirements.

2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.

3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.

4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.

D. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with local Health Department requirements.

1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.

2. For clearances less than 1-1/2 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Owner's Representative, at no additional cost to the Owner.

E. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.

1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.

2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.

3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.

4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.

5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

F. Remove water or materials that interfere with Work.

1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.

2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.

3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Owner's Representative.

4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.

5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.

    a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Owner's Representative.

    b. Coordinate with Owner's Representative prior to plugging.

    c. For plugs less than 36 inches in diameter, 8-inch-deep masonry units shall be used. For plugs in larger pipelines, 12-inch-deep masonry units shall be used.

6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.

G. Do not interfere with 45 degree bearing splay of foundations.

H. Over-excavation for Unsuitable Trench Foundation Conditions:

1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Owner's Representative to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.

2. Unsuitable materials shall be removed and replaced only as directed in writing by Owner's Representative.

3. Unsuitable materials encountered shall be removed and replaced with Imported Structural Fill Type A1, 3/4-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.

a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.

b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.

c. Place laps or splices in the geotextile in the direction of the pipe laying.

I. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

J. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic or interfere with the function of existing drainage facilities or system operation.

K. Remove excess subsoil not intended for reuse from site.

L. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks, and other structures.

1. The Owner's Representative must approve tunneling methods prior to utility installation.

2. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks, and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.

F. Construction Sheeting Left in Place:

1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.

2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Owner's Representative. All such sheeting and bracing left in place shall be included in the cost for excavation.

3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Owner's Representative to be left in place. The right of the Owner's Representative to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Owner's Representative to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.

4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor's compaction methods.

B. Moisture Control:

1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.

2. Add moisture to granular backfill by sprinkling during compaction operation.

3. Compaction by ponding or jetting is not permitted.

C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Owner's Representative, in place by whatever equipment and method is practicable or specified, and as approved by the Owner's Representative.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.

B. Unless otherwise noted in the Drawings, pipe, or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.

C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.

1. In lieu of a detail, the depth shall be 6 inches.

D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.

E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction.

F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.

G. Check grade and correct irregularities in bedding material.

H. Center pipes horizontally in trench width.

3.12 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Maintain optimum moisture content of fill materials to attain required compaction density.

D. Place fill material, with the exception of CLSM, in continuous layers and compact in 6- to 8-inch lifts.

1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways, or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class B or Class E and pipe zone backfill shall be Class B or Class E. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.

3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways, or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.

F. Do not use power-driven impact compactors to compact pipe zone material.

G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Owner's Representative.

H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.

I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.

J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

K. Placement of Sand:

1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.

2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

L. Placement of CLSM:

1. Discharge from truck-mounted drum-type mixer into trench.

2. Place in lifts not exceeding 2 feet in thickness.

3. No compaction of CLSM is allowed.

4. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed if it has hardened sufficiently to prevent rutting.

M. New trenching shall not be started when earlier trenches need backfilling, or the surfaces of streets or other areas need to be restored to a safe and proper condition.

N. Do not leave trench open at end of working day.

3.13 NOT USED

3.14 ELECTRONIC LOCATING FACILITY INSTALLATION

A. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.

b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.

c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

a. Install locator stations as shown within manholes.

b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.

c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.

d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station and attach to one of the lugs in the locator station.

e. When multiple tracer wires are terminated in manhole install a multi-lead locator station.

f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.

g. Install ground wire approximately 3 feet deep and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.

h. Seal all holes drilled in manhole walls with silicone sealant.

3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:

a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.

b. Seal hole with silicon sealer or material approved by Owner's Representative.

c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Owner's Representative.

3.15 VISUAL IDENTIFICATION FACILITIES

A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Owner's Representative.

3.16 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per 200 lineal feet of pipeline trench as measured along pipe centerline.

1. The Owner's Representative may reduce the frequency when satisfied with method of compaction.

2. The Owner's Representative may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.

3. The Owner's Representative shall determine all test locations.

D. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM 1557
2. Moisture Tests: ASTM D2216

E. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

3.17 SURFACE RESTORATION AND CLEANUP

A. Open Trenches: At the end of each workday, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Owner's Representative and the local permitting agency.

1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the Owner's Representative.

2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.

B. Topsoil:

1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.

2. Topsoil shall not be mixed with other excavated material.

3. After the trench has been backfilled, the topsoil shall be replaced.

C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

3.18 NOT USED

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes temporary dewatering and surface water control systems for open excavations and utility trenches.

B. Section includes:

1. Dewatering systems.
2. Surface water control systems.
3. System operation and maintenance.
4. Water disposal.

1.2 SUBMITTALS

A. Dewatering Plan:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply; pollution control facilities; discharge locations to be utilized; and provisions for immediate temporary water supply as required by this Section.

2. Plan to be reviewed by the Owner's Representative prior to the beginning of construction activities requiring dewatering. Review by the Owner's Representative of the design shall not be construed as a detailed analysis of the adequacy of the dewatering system, nor shall any provisions of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

1.3 DEFINITIONS

A. Dewatering includes the following:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and /or shafts.

2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and /or shafts.

3. Disposing of removed water.

B. Surface Water Control: Removal of surface water within open excavations.

1.4 QUALITY CONTROL

A. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

B. Provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents.

C. Secure all necessary permits to complete the requirements of this Section.

D. Control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

E. Where the critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop.

1. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor.

2. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DEWATERING

A. Provide all equipment necessary for dewatering.

1. Have on hand, at all times, sufficient pumping equipment and machinery in good working condition.

2. Have available, at all times, competent workers for the operation of the pumping equipment.

3. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. Site Grading:

1. At all times, site grading shall promote drainage.

2. Surface runoff shall be diverted from excavations.

3. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

F. Maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

G. Flotation shall be prevented by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

I. Dispose of water from the work in a suitable manner without damage to the environment or adjacent property. No water shall be drained into work built or under construction without prior consent of the Owner's Representative. Water shall be filtered using an approved method to remove sand and fine sized soil particles before disposal into any drainage system.

J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

K. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the work and all costs thereof shall be included in the various contract prices in the bid forms.

END OF SECTION

SECTION 31 23 23 – FILL

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under all other areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.

B. Section includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.
6. Other areas receiving fill.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.3 DEFINITIONS

A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.

B. Imported Material: Materials obtained from sources offsite, suitable for specified use.

C. Lift: Loose (uncompacted) layer of material.

D. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Imported Materials:

1. Materials Source: Submit name and location of imported fill materials suppliers.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

C. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.5 QUALITY ASSURANCE

A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.

B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.

C. CLSM:

1. In-place testing: In accordance with ASTM C403.
2. Compressive testing: In accordance with ASTM D4832.

D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S2, General Imported Structural Fill Material, as specified in Section 31 05 13, Soils for Earthwork.

B. Imported Structural Fill: Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

C. Concrete:

1. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.

D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.

E. Foundation Stabilization Material: Imported Structural Fill Type A1, Dense-Graded Aggregate, 3/4-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Owner's Representative as to the nature and extent of the differing conditions.

B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.

C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE CONDITIONS

A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.

B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Owner's Representative to quell dust.

C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Control of Water:

1. Excavated areas shall be kept free of water and frost.

2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.

3. The existing site soil is highly moisture sensitive and will be difficult to work or compact if moisture contents are greater or less than the optimum moisture content by about 3 percentage points. Accordingly, earthwork using these moisture sensitive soils during or after periods of wet weather should be avoided, if possible. If earthwork activities cause excessive subgrade disturbance, replacement with structural fill might be necessary. Additionally, the natural moisture content of these soil units could be more than about 3 percent above optimum at the time earthwork is performed. Therefore, proper moisture conditioning might be required, such as scarifying and aerating, to achieve suitable moisture contents before the soil can be reused on site.

4. Disturbance to a greater depth also should be expected when site preparation work is conducted during periods of wet weather, or if the soil moisture content is near saturation.

C. Per the Geotechnical report, do not compact or proof roll subgrade prior to placing fill.

D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Over-excavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.

E. Subgrade to be approved by Owner's Representative prior to placement of structures and commencement of backfill activities.

F. Place geotextile on subgrade prior to placement of fill as shown on the drawings.

G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.

B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.

C. Maintain optimum moisture content of backfill materials to attain required compaction density.

D. Employ placement method that does not disturb or damage other work.

E. Mechanical tampers permitted in confined areas.

F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

G. Structural fill shall be placed in loose lifts not exceeding 8 inches in thickness (or a thickness compatible with the compaction equipment used, not to exceed 12 inches) and mechanically compacted to a firm condition. Each lift shall be conditioned to the proper moisture content and compacted to the following densities based on the ASTM International (ASTM) D 1557 laboratory test procedure.

1. Soil used as structural fill placed within the proposed building footprint, regardless of depth below floor subgrade or foundation grade, should be compacted to at least 92 percent of MDD.

2. Structural fill in roadway access and parking areas, including utility trench backfill, should be compacted to at least 90 percent of the MDD, except the upper 2 feet of fill below final subgrade should be compacted to a minimum 95 percent of the MDD.

H. Foundation Base for Structures:

1. Bring excavation to required subgrade elevation shown in the Drawings.

2. Place foundation base material to required grade shown in the Drawings.

3. Place foundation base material in 6-inch lifts and compact to 95 percent maximum dry density.

4. Pump Station:

    a. Concrete Footings and Slabs: Place material as shown on Drawings.

I. Backfill for Structures:

1. Prior to placing backfill, remove forms, temporary construction, and debris below grade.

2. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour, unless otherwise approved by Owner's Representative.

3. Heavy compactors and large pieces of construction equipment shall be kept away from any embedded wall a distance of a least 5 feet in order to avoid the build-up of excessive lateral pressures.

    a. Over-compaction of fill near walls should be avoided.

4. Compaction within 5 feet of the walls shall be accomplished using hand-operated vibratory plate compactors or tamping units.

5. The maximum particle size of granular material placed against buried structures shall be limited to no greater than 1-1/2-inch diameter.

6. Structural fill backfill material shall be brought up on all sides of the walls and footings in such a manner as to avoid adverse differential lateral earth pressures on the vertical surfaces.

7. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.

    a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.

    b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.

8. Particular care must be taken to avoid damage to the pipe connections to the structure.

9. Utility trench backfill within 10 feet of all structural perimeters shall meet the requirements for structural fill.

J. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as roadways, driveways, and parking lots

1. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.

a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.

b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.

2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.

K. Slope grade away from building minimum 2 percent slope for minimum distance of 5 feet, unless noted otherwise in the Drawings.

L. For all fill areas unless noted above, place Subsoil Fill: Type S2 directly on top of undisturbed site soil. The first two lifts of fill should be maximum 6-inch-thick lifts and should be compacted using static methods. Subsequent lifts may be compacted using vibratory methods.

M. Make gradual grade changes. Blend slope into level areas.

3.5 FIELD QUALITY CONTROL

A. All testing and reporting shall be conducted and completed by the Contractor.

B. Perform laboratory material tests in accordance with ASTM D698 (AASHTO T99).

C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Owner's Representative shall be provided with the results of each compaction test at the time of testing.

D. In-place compaction testing for gravel access road shall be performed at 6-inch elevation increments in the fill material with at a minimum of one test per each 200 lineal feet of gravel roadway. The Owner's Representative shall be provided with the results of each compaction test at the time of testing.

E. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D1557.
2. Moisture Tests: ASTM D2216.

F. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

3.7 NOT USED

END OF SECTION

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

This section includes the construction of asphalt concrete pavement.

1.2 REFERENCE STANDARDS

A. References herein to "AASHTO" shall mean Association of American State Highway Transportation Officials.

B. Standard Specifications: Where the term "Standard Specifications" is used, such reference shall mean the current edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Highway Construction. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 DEFINITIONS

A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.4 SUBMITTALS

A. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00640 for aggregate used in aggregate base.

B. Aggregate Qualification Tests: In accordance with Standard Specifications Section 00745 for aggregate used in asphalt concrete.

C. Job mix formula shall be an approved job mix formula. Submit formula, supplier, and product identification to the Owner's Representative 30 days prior to start.

1. Definite percentage for:

    a. Each sieve fraction.
    b. New asphalt cement.
    c. Recycled asphalt pavement.

2. Temperature of completed mix when discharged from mixer.

3. Character and quantity of anti-strip and recycling agents.

1.5 QUALITY ASSURANCE

A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Owner's Representative. All testing costs shall be borne by the Contractor.

B. A minimum of five nuclear densometer readings shall be taken in random locations within every test area. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Owner's Representative.

C. The surface smoothness of the new asphalt concrete pavement shall be such that when a 10-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/8-inch. Surface drainage shall be maintained. Additionally, paving must conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Owner's Representative. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 1-1/2-inch depth and replacing with Level 3, 1/2-inch dense graded Asphaltic Concrete the full width at no cost to Owner.

1.6 PRE-PAVING CONFERENCE

A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Owner's Representative, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.

B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

A. Aggregate Base for Dense Graded Asphalt Concrete: As shown in drawings

2.2 ASPHALT CONCRETE PAVEMENT

A. Dense Graded Hot Mix Asphalt Concrete

1. Use Level 2, 1/2-inch-dense graded, PG 64-22 HMAC. Conform to the requirements as specified in Section 00745 of the Standard Specifications. Conform to the requirements as specified in Section 00745 of the Standard Specification.

2. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.

3. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 30 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Owner's Representative.

B. Tack Coat

In accordance with Standard Specifications. Use AR 4000, AC-20 asphalt, or CSS-1 emulsified asphalt C.

C. Seal and Cover Coat

Asphalt material shall be CRS-2 cationic emulsified asphalt. Cover stone shall conform to size 1/4-inch #10 aggregate in the Standard Specifications.

D. Subgrade Geotextile: As shown on drawings.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

A. Place pavement base to the depth shown on the plans or as specified in all cases, pavement base shall be compacted to a minimum depth of 6 inches. Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.

B. Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 95 percent of the maximum density, as determined by AASHTO T-99.

C. Obtain the Owner's Representative's acceptance of the subgrade before beginning construction of the aggregate base course.

D. When, in the judgment of the Owner's Representative, the weather is such that satisfactory results cannot be secured, suspend operations. Place no aggregate base course in snow or in soft, muddy, or frozen subgrade.

E. Refer to Specification 31 23 23, Fill for additional requirements.

3.2 ASPHALT CONCRETE PAVEMENT

A. Construct asphalt concrete pavement in accordance with Section 00745 of the Standard Specifications.

B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes, and like items. When rate is not specified, asphalt will be applied at the rate of 0.1-gallon per square yard.

C. Obtain the Owner’s Representative's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.

D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40 degrees Fahrenheit (F) or warmer, unless otherwise authorized by the Owner’s Representative.

E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Owner’s Representative, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.

F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Owner’s Representative. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.

G. Compact the bituminous mixture to at least 92 percent of the Theoretical Maximum Density.

H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

I. The surface of each layer when tested with a Contractor-furnished 10-foot straightedge shall not vary from the testing edge by more than 0.02-foot for underlying courses of pavements and 0.015-foot for finished top courses or wearing courses of pavements. At no point shall the finished top of the wearing course vary more than 0.03-foot from the specified finished grade.

J. Lift thickness shall be as shown on the drawings or specified, but not to exceed 3 inches.

K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.

L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 FIELD QUALITY CONTROL

A. Job mix will be sampled immediately behind the paving machine.

B. Temperature of the mix will be measured immediately behind the paver.

C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.

D. Properties of the job mix will be measured using ASTM D2041.

E. Density of the compacted job mix will be measured in accordance with ASTM D2922.

3.4 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

Prior to placing asphalt concrete pavement, the Contractor shall make all necessary adjustments to existing manhole frames and covers, and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

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SECTION 33 01 30.13 - STORM AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes methods for testing of gravity storm piping and manholes.

B. Section includes:

1. Testing of Gravity Storm Piping:

   a. Low pressure air testing.

2. Deflection testing of plastic storm piping.

3. Testing of Manholes:

   a. Vacuum testing.
   b. Exfiltration testing.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

B. American Water Works Association:

1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances.

2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.

4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.
6. Deflection mandrel drawings and calculations.

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump.

2. Vacuum line.

3. Vacuum Tester Base:

   a. Compression band seal.
   b. Outlet port.

4. Shutoff valve.

5. Stopwatch.

6. Plugs.

7. Vacuum Gage: Calibrated to 0.1 in. Hg (0.34 kPa).

2.2 EXFILTRATION TESTING

A. Equipment:

1. Plugs.
2. Pump.
3. Measuring device.

2.3 AIR TESTING

A. Equipment:

1. Air compressor.
2. Air supply line.
3. Shutoff valves.
4. Pressure regulator.
5. Pressure relief valve.

6. Stopwatch.
7. Plugs.
8. Pressure Gage: Calibrated to 0.1 psi.

2.4 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

2.5 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels.
2. Pull/retrieval ropes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify manholes and piping are ready for testing.
B. Verify trenches are backfilled.
C. Verify pressure piping thrust restraint system is installed, as may be required.

3.2 PREPARATION

A. Obstructions:

1. After backfilling and restoration of surfaces, gravity pipelines shall be inspected for obstructions and shall be cleaned.

2. Pipes less than 24 inches in diameter shall be cleaned using the sewer ball method.

3. Lines larger than 36 inches in diameter may be cleaned by flushing as long as they are first visually inspected to assure that no physical obstructions exist.

a. Flushing shall be such that velocities are at least 2.5 feet per second.

B. Lamping:

1. Lamp gravity piping after flushing and cleaning of lines, checking manholes for unfinished work.

2. Perform lamping operation by shining light at one end of each pipe section between manholes.

3. Observe light at other end.

4. Pipe not installed with uniform line and grade will be rejected.

5. Remove and reinstall rejected pipe sections.

6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Testing of Gravity Sewer Piping:

1. Low Pressure Air Testing:

a. Test each reach of gravity storm piping between manholes.

b. Introduce air pressure slowly to approximately 4 psig.

1) Determine ground water elevation above spring line of piping.

2) For every foot of ground water above spring line of piping, increase starting air test pressure by approximately 0.4 psi.

3) Do not increase pressure above 10 psig.

c. Allow pressure to stabilize for at least five minutes.

d. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.

e. Testing:

1) Determine test duration for reach of storm with single pipe size from following table; do not make allowance for laterals.

Table 33 01 30.13 -1
Air Testing Duration for Gravity Sewer Piping

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4

2) Record drop in pressure during testing period.

3) If air pressure drops more than 1.0 psi during testing period, piping has failed.

4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.

5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and the requirements of Section 33 13 00, Testing and Disinfection of Water Utility Piping.

C. Deflection Testing of Plastic Storm Piping:

1. Perform vertical ring deflection testing on PVC storm piping after backfilling has been in place for at least 30 days but not longer than 12 months.

2. Allowable maximum deflection for installed plastic storm pipe is no greater than five percent of original vertical internal diameter.

3. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.

4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122.

5. Perform testing without mechanical pulling devices.

6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

D. Testing of Manholes:

1. Description:

   a. Option of air testing or exfiltration testing.

   b. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.

   c. Repair both outside and inside of joint to ensure permanent seal.

   d. Test manholes with manhole frame set in place.

2. Vacuum test according to ASTM C1244 and following:

   a. Plug pipe openings; securely brace plugs and pipe.

   b. Inflate compression band to create seal between vacuum base and structure.

   c. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg .

   d. Close valve.

   e. Testing:

      1) Determine manhole testing duration using following table:

MANHOLE DIAMETER (feet)	TEST PERIOD
4	60 seconds
5	75 seconds
6	90 seconds

      2) Record vacuum drop during test period.

      3) If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.

      4) If vacuum drop of 1 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.

      5) If vacuum test fails to meet 1 in. Hg drop in specified time after repair, repair and retest manhole.

3. Exfiltration Testing:

   a. Plug pipes in manhole.

b. Remove water from manhole.

c. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.

d. Determine ground water level outside manhole.

e. Fill manhole with water to its rim at the start of the test.

f. Prior to testing, allow manhole to soak from minimum of four hours to maximum of 72 hours.

g. After soak period, adjust water level to rim of manhole.

h. Leakage in the manhole shall not exceed 0.2 gallons per foot of head above the highest invert after a one-hour test period.

4. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.

5. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

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SECTION 33 05 64 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete valve vaults.
2. Precast concrete meter boxes.

1.2 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM A536 - Standard Specification for Ductile Iron Castings.
4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. ASTM C33 - Standard Specification for Concrete Aggregates.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

16. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).

17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 COORDINATION

A. Coordinate Work with utilities within construction area.

B. The drawings identify precast vaults and meter boxes by Manufacturer and model number. This information is provided for dimensional information only. Provide precast items in accordance with the requirements of this Section.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on valve vaults and meter boxes.

C. Shop Drawings for Precast Concrete Valve Vaults:

1. Indicate plan, location, and inverts of connecting piping.
2. All interior and exterior dimensions.
3. Location and type of lifting inserts, connection embeds, and joints.
4. Details of reinforcement.
5. Covers or hatches.
6. Ladders and grating.

D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.6 QUALITY ASSURANCE

A. Perform Work according to standards identified in Article 1.2 herein.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.

B. Transport and handle precast concrete units with equipment designed to protect units from damage.

C. Storage:

1. Store precast concrete valve vaults and meter boxes according to Manufacturer instructions.

2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Performance and Design Criteria:

1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:

a. Manufactured to conform to ASTM C913.

2. Loading:

a. Design to ASTM C890-A16 / AASHTO HS20 live loading and installation conditions.

b. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil.

c. Lateral loads:

1) Static: 105 x Depth of fill per square foot (psf) triangular equivalent fluid pressure plus a surcharge of an additional 3 feet of soil depth in areas

subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise by the Contract Documents).

2) Seismic acceleration: UBC Zone 3 requirements (I = 1.25) where I = importance factor, I = 1.25, but not less than 0.20 grams (g) acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.

3. Minimum 28-Day Compressive Strength: 3,000 pounds per square inch (psi).

4. Honeycombed or re-tempered concrete is not permitted.

5. No knockouts shall be cast into vault walls. All pipe penetrations shall be pre-formed or core-drilled at the required locations.

6. Accessories: Accessories such as ladders, floor grates at sumps, and other features shall be provided as shown on the Drawings.

7. Size: Vault dimensions shall be as required by the Drawings.

2.2 PRECAST CONCRETE VALVES AND METER BOXES

A. Manufacturers:

1. Oldcastle, Inc
2. Or equal

B. Valve Vault and Meter Box Frames and Covers:

1. Cast Iron Castings:

a. ASTM A48, Class 30 or better.
b. Free of bubbles, sand, air holes, and other imperfections.

C. Access Steps:

1. Steel reinforced formed polypropylene:

a. ASTM C478
b. Reinforced rod: ASTM A615, Grade 60, 1/2-inch diameter

2. Aluminum: ASTM B221, Alloy 6061-T6

3. Width: Minimum 12 inches

4. Spacing: 12 inches on center vertically.

2.3 ACCESS HATCHES AND LIDS

A. Unless noted otherwise elsewhere in the Contract Documents, vaults shall have concrete top slabs with access openings as shown on the Drawings.

B. Vault manufacturer shall provide the access hatches per the requirements of Section 08 30 00, Access Hatches.

C. Lids shall have lifting holes.

D. When leveling bolts are used to set the vault top sections, ensure the load from the top slab is transferred through grout to the vault walls so that the load is not carried by the leveling bolts.

2.4 MATERIALS

A. Portland Cement:

1. ASTM C150, Type II

B. Coarse Aggregates:

1. ASTM C33
2. Graded 1 inch to No. 4 sieve

C. Sand:

1. ASTM C33
2. Fineness Modulus: 2.35

D. Water:

1. Potable.

2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.

E. Air-Entraining Admixtures: ASTM C260

F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 40 minimum
2. Welded Wire Fabric: ASTM A185

G. Gaskets:

1. Rubber gaskets: ASTM C443

H. Joint Sealant:

1. ASTM C990

I. Bedding:

1. Aggregate Bedding Material: Type A1 ¾-inch-0 as specified in Section 31 05 16, Aggregates for Earthwork. Size as shown in the Drawings.

J. Drain Rock:

1. Drain Rock Material Type A2 ¾-inch- ½ -inch as specified in Section 31 05 16, Aggregates for Earthwork.

2.5 FABRICATION

A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

B. Vaults may be formed with separate top and bottom slabs.

C. Walls shall be cast so that all sides are continuous at corners and their full length with no block-outs or knockouts.

D. Horizontal joints may be provided so that walls can be placed in horizontal segments.

E. All horizontal joints shall be keyed to prevent offsets and shall be provided with a watertight gasket.

F. Finish:

1. Formed surfaces shall be smooth and uniform with no fins, bulges, or other irregularities.

2. Any void greater in width than 1/2-inch or deeper than 3/8-inch shall be repaired.

3. Unformed interior slab surfaces shall have a smooth steel trowel finish.

4. Unformed exterior slab surfaces shall have a light broom finish applied to a steel trowel finish.

2.6 MIXES

A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe ends and remove burrs.

B. Remove scale and dirt from components before assembly.

C. Establish invert elevations for each component in system.

D. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

A. Vaults/Meter and Bedding:

1. Excavate as specified in Section 31 23 16, Excavation for Work of this Section.

2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.

3. Place bedding material level in one continuous layer to a minimum compacted depth of 6 inches.

4. Place drain rock below any drains or on sides of vault for hatch drain pipe.

5. Compact bedding material to 95 percent maximum density.

6. Bases for precast concrete structures shall be set level so that bedding material fully and uniformly supports them in true alignment with uniform bearing throughout full perimeter. Do not level bases by wedging gravel under the edges.

7. Backfill around sides of vaults and meter boxes as required by the Drawings.

B. Connect piping.

1. Pipe penetrations shall be located and sealed as shown on the drawings. All pipe penetrations shall be preformed or core drilled to produce a smooth hole to allow for the installation of the specified sealing device.

2. If the contract drawings do not specify a sealing method then the annular space between the pipe and concrete shall be filled with non-shrink grout.

3.4 FIELD QUALITY CONTROL

A. Request examination of subgrade by Owner's Representative prior to placing aggregate base under precast materials.

B. Compaction Testing: In accordance with Field Quality Control requirements of Section 31 23 23, Fill.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

D. Frequency of Compaction Tests: In accordance with Section 01 45 00, Quality Control.

END OF SECTION

SECTION 33 11 10 - WATER UTILITY DISTRIBUTION AND TRANSMISSION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Work under this Section applies to furnishing and installation of buried pipe materials, fittings, and appurtenances normally encountered with water distribution and transmission systems, including potable water and fire water systems. Work for in-plant piping for pump stations and vaults, see Section 40 05 13, Common Work Results for Process Piping.

B. Section includes:

1. Pipe and fittings
2. Flexible couplings
3. Flanged coupling adapters
4. Insulating flanged joints
5. Tapping sleeves and valves
6. Flexible expansion joints
7. Bedding and cover materials

C. Related Requirements:

1. General

a. Furnish and install all piping systems shown and specified in accordance with the requirements of the Contract Documents.

b. Each buried piping system shall be complete, with all necessary fittings, valves, accessories, lining and coating, testing, excavation, backfill and encasement, to provide a functional installation.

c. Piping layouts shown in the Drawings are intended to define the general layout, configuration, and routing for pipe, as well as the size and type of piping to be installed. The piping plans are not pipe construction or fabrication drawings.

d. The Contractor shall cause the Supplier of pipes, valves, fittings, and appurtenances to coordinate piping installation such that all equipment is compatible and is capable of achieving the performance requirements specified in the Contract Documents.

e. It is the Contractor’s responsibility to develop the details necessary to construct all piping systems, to accommodate the specific equipment provided, and to

provide and install all spools, spacers, adapters, connectors, valves, gaskets, fittings, appurtenances etc., for a complete and functional system.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

B. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy, and other Special Alloys

3. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges

4. ASME B31.10 - Standards of Pressure Piping

C. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

3. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

5. ASTM A536, Standard Specification for Ductile Iron Castings.

6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

7. ASTM D1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

10. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

D. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast

7. AWWA C153 - Ductile-Iron Compact Fittings

8. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe

9. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances

10. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

11. AWWA C606 - Grooved and Shouldered Joints

12. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm), for Water Transmission and Distribution

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joints between Tapping Sleeves and Tapping Valves

F. NSF International (NSF):

1. NSF Standard 61 - Drinking Water System Components – Health Effects
2. NSF Standard 372 - Drinking Water System Components – Lead Content
3. NSF 600 – Health Effects Evaluation and Criteria for Chemicals in Drinking Water

G. SUBMITTALS

H. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

I. Product Data: Submit data on pipe materials, pipe fittings, restrained joint systems, and accessories.

J. Shop Drawings: Indicate piping layout, including piping specialties.

1. Layout Schedule for applicable segments of proposed transmission main alignment. Schedule shall include layout plan and dimensions, schedule of pipe fittings and specials, materials and class for each size and type of pipe, joint details, pipe supports, and any special provisions required for assembly.

K. Lining and coating data.

L. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

M. Manufacturer’s handling, delivery, storage, and installation requirements.

N. Field Quality-Control Submittals:

1. Pipeline hydrostatic testing plan.
2. Indicate results of Contractor-furnished tests and inspections.

O. Preconstruction Photographs:

1. Submit digital files of colored photographs of Work areas and material storage areas.

1.3 CLOSEOUT SUBMITTALS

A. As-Built Drawings:

1. Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 QUALITY ASSURANCE

A. Materials:

1. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

2. All material of a like kind shall be provided from a single manufacturer unless otherwise approved by the Owner's Representative.

3. All material shall be carefully handled and installed in good working order free from defect in manufacture, storage, and handling.

B. Markings:

1. Pipes and Fittings: Mark each pipe and fitting at plant. Include date of manufacture, Manufacturer's identification, specification standard, inside diameter of pipe, dimension ratio as applicable, pipe class as applicable, pipe number for laying purposes as applicable, and other information required for type of pipe.

2. Bolting materials (washers, nuts, and bolts) shall be marked with material type.

C. Testing:

1. Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards.

1.5 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. In accordance with Manufacturer's written recommendations and as specified in these Contract Documents.

B. Pipe, specials, and fittings delivered to Project Site in damaged condition will not be accepted.

C. Storage:

1. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

2. Pipe and fittings shall not be stored on rocks, gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

3. Do not store materials in direct sunlight.

4. Gaskets: Do not allow contact with oils, fuels, petroleum, or solvents.

D. Handling:

1. Pipe and appurtenances shall be handled in accordance with Manufacturer's recommendations or requirements contained in this section or subsequent sections dealing with the specific pipe material, whichever is more stringent.

2. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

3. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

4. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

E. Pipe Plugs:

Provide and install a cap or plug on each end of pipe during transportation and onsite storage to protect linings and coatings from debris. Install watertight plug-in end of installed pipe at the end of the workday. Under no circumstances shall materials be dropped or dumped into the trench.

PART 2 PRODUCTS

2.1 WATER PIPING

A. General

1. All piping materials and specials shall meet the specifications of this Section and of the appropriate AWWA Standard Specifications. In the case of conflict, the more stringent specifications shall apply.

2. All coatings and materials specified herein which may come in contact with potable water shall conform to National Sanitation Foundation (NSF) Standard 61, 372 and 600.

3. Minimum Pressure Ratings: Unless otherwise specified herein or shown in the Drawings, the minimum working pressure rating of all water works materials specified herein shall be 1-1/2 times the operating pressure or 150 pounds per square inch (psi) minimum.

4. Gaskets:

    a. Material: Neoprene rubber, 55-65 durometer hardness.

B. Ductile Iron Pipe:

1. Centrifugally cast, conforming to AWWA Standard C151.

2. Coating: Asphaltic exterior coating in accordance with AWWA Standard C151.

3. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.

4. Pipe Thickness Class:

    a. Comply with AWWA C151.

    b. Class 52, unless shown to be greater in the Plans.

        1) The Contractor shall be aware ductile iron piping with thickness class greater than Class 52 may have long fabrication and supplier lead times. The Contractor shall be responsible for coordinating product submittal and delivery times accordingly such as not to delay construction.

5. Gauged Pipe:

    a. All ductile iron pipe 24-inch diameter or greater to be cut in the field shall be gauged full length. The select piping shall meet the outside diameter standard dimensions and tolerances required for spigot ends along the full length of pipe to within 2 feet of the bell end.

    b. In addition to pipe supplied for anticipated cutting, a minimum of 5 percent of each size of piping 24-inch diameter or greater shall be provided gauged full length as described above.

    c. Pipe shall be externally marked, in Manufacturer's color, indicating gauged pipe.

6. Joints:

    a. Joint types shall be provided as identified in the Drawings and as required for the application.

    b. Mechanical Joints:

        1) Comply with AWWA C111.

c. Push-on Joints:

1) Comply with AWWA C111.

2) Manufacturers, without exception:

a) Tyton Joint by American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, McWane, and Pacific States Cast Iron Pipe.

b) Fastite Joint by American Cast Iron Pipe Company.

d. Restrained Joints:

1) Joint restraint for pipe shall be accomplished with an integral lock mechanism, except as may be otherwise specified.

a) Any such system shall be a manufacturer's standard proprietary design, shall be as recommended by the Manufacturer for the application, and shall be performance proven.

2) Restraining components:

a) Ductile iron complying with AWWA C110 and/or C153, with the exception of a manufacturer’s proprietary design dimensions.

b) Push-on joints for such fittings shall comply with AWWA C111.

3) Deflection:

a) The maximum pipe deflection shall not exceed one-half of the Manufacturer’s stated joint deflection allowance.

4) Manufacturers:

a) “TR Flex”, United States Pipe and Foundry Company.

b) “Field-Lok”, United States Pipe and Foundry Company.

c) “MJ-TJ” pipe with “MEGALUGs”, Pacific States Cast Iron Pipe Company.

d) “MEGALUG”, EBAA Iron, Inc.

(1) Where any restrained joint system requires the use of a wedge-type mechanical restraint gland for restraint, the glands shall be provided in quantities as may be required and shall be considered incidental to the joint restraint system.

(2) Wedge-type mechanical restraining glands shall not be used to restrain the plain end of plain end ductile iron or cast iron fittings.

5) "Foster Adaptor", Infact Corporation

a) Where specified, mechanical joint (MJ) valves and fittings shall be connected using a bolt-through positive restraint mechanism manufactured of ductile iron conforming to ASTM A536, 65-45-12.

b) The positive restraint device shall connect the valves and/or fittings at a linear distance not to exceed three (3) inches and without attachment to pipe.

c) The device shall come complete with all accessories, including standard styrene butadiene rubber (SBR) MJ gaskets conforming to the latest revision of AWWA C111/ASTM F-477 and weathering steel (Corten) bolts conforming to AWWA C111/A21.11 and ASTM A242.

d) Nuts for 3 through 12-inch sizes shall be SAE Grade 5 steel with black oxide coating. Nuts for 14-inch and larger adaptors shall be heavy hex Corten steel conforming to ASTM A242.

e) MJ positive restraining device shall be supplied with NSF 61, 7-mil. fusion bonded epoxy conforming to AWWA C116/A21.16-09 as well as the coating, surface preparation and application requirements of ANSI/AWWA C550.

f) The device shall be used with standard mechanical joint fittings (AWWA C110 or C153) and valves and shall be Infact Corporation FOSTER ADAPTOR or equal.

e. Flanged Joints:

1) Flat faced, complying with AWWA C111 and C115, unless otherwise specified.

2) Bolt hole drilling according to ASME/ANSI B16.1, Class 125, or ASME/ANSI B16.1, Class 250, where specified. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

3) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain mating pipe, valve, and fitting flanges match in bolt pattern.

4) Pressure rating of flange joints shall not exceed the rating of the pipe or fitting of which they are a part, and the maximum pressure rating of the joint shall be 250 psi.

5) Flange joint connections shall not be exposed to test pressures greater than 1-1/2 times their rated working pressure.

6) Threaded flanges:

a) Ductile iron pipe spools with threaded flanges shall conform to AWWA C115.

b) Installed only on pipe with a minimum Class 53 wall thickness.

7) Buried flanges:

a) Flanged connections shall not be buried unless shown as such on the Drawings.

b) Buried flanges shall be wrapped with 2 layers of 10-mil tape along edges of flanges.

8) Gaskets:

a) Full faced, 1/8 inch thick, neoprene rubber, 55-65 durometer hardness. Dimensions shall be per ANSI B16.21.

b) Ring gaskets shall not be permitted.

C. PVC:

1. All PVC pressure pipe shall be manufactured with an integral bell design capable of receiving an elastomeric gasket.

2. All PVC pressure pipe shall be dimensionally compatible with standard cast/ductile iron fittings produced according to AWWA C110 or AWWA C153, as applicable.

3. Deflection:

a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

b. Deflection by bending of the pipe rather than at the joints is not allowed.

c. The maximum pipe deflection shall not exceed one half of the Manufacturer's stated joint deflection allowance.

4. Joints:

a. Solvent-cement couplings are not permitted.

5. Gaskets: Comply with ASTM F477.

6. Size: 4-inch through 12-inch diameter

    a. Comply with AWWA C900, DR 14, Class 305, unless shown otherwise in the Drawings or specified elsewhere.

7. Size: 14-inch through 48-inch diameter

    a. Comply with AWWA C900, DR 18, Class 235, unless shown otherwise in the Drawings or specified elsewhere.

8. Restrained Joints:

    a. For push-on pipe joint at pipe bells:

        1) Material:

            a) Body: Ductile iron. Comply with ASTM A536.
            b) Bell Restraint Systems: Corten steel tie rods.

        2) Coatings: Shop-applied liquid epoxy.

        3) Construction:

            a) A split serrated ring shall be used behind the pipe bell. A split serrated ring shall also be used to grip the pipe and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring.

            b) System shall be designed for a minimum 2 to 1 safety factor.

        4) Manufacturers:

            a) 4-inch through 12-inch diameter: EBAA Iron, Inc. - Series 1900 Bell Restraint Harness.

            b) 14-inch through 48-inch diameter: EBAA Iron, Inc. - Series 2800 Bell Restraint Harness.

    b. At mechanical joint fittings:

        1) Material: Ductile iron. Comply with ASTM A536.

        2) Coatings: Shop-applied liquid epoxy.

        3) Construction:

a) Restraint accomplished by a restraint device consisting of a follower gland utilizing multiple gripping wedges.

b) The restraint system shall have a sufficient number of fastening bolts to connect the ring to the mechanical joint.

c) System shall be designed for a minimum 2 to 1 safety factor.

4) Fasteners:

a) T-bolts and nuts: High strength, low alloy steel.
b) Comply with AWWA C111.

5) Manufacturers:

a) EBAA Iron, Inc. - MEGALUG, Series 2000PV
b) Romac Industries, Inc. – 470 Series Pipe Restraining System

2.2 FITTINGS

A. Material: Ductile iron, complying with AWWA Standard C110.

1. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

B. Fittings used for joining ductile iron and PVC pipe shall be of the type, size, and strength designated on the Plans, elsewhere in the specifications.

1. Fittings shall be mechanical joint, push-on type, flanged or plain-end as required and shown on the Drawings.

2. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

C. Pressure ratings: As specified for joining pipe above and as shown on the Drawings.

D. Coating and Lining:

1. Asphaltic exterior coating in accordance with AWWA Standard C110.
2. Cement Mortar Lining: Comply with AWWA C104.

E. Following information cast upon fittings:

1. Manufacturer’s identification.
2. Country of manufacture.
3. Pressure rating.
4. For bends, number of degrees and/or fractions of a circle.

F. Owner may require additional metallurgical documentation or other certifications.

2.3 NUTS, BOLTS, AND WASHERS

A. All bolts shall have heavy hex head with heavy hex nuts.

B. For operation pressures of 150 psi or less:

1. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
2. Nuts: Comply with ASTM A563A, Heavy Hex.
3. Washers: Comply with ASTM F844.

2.4 UNDERGROUND PIPE MARKERS

A. As specified in Section 31 23 17, Trenching.

2.5 BEDDING AND COVER MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.

1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2) Subsoil Fill Type S1, as specified in Section 31 05 13, Soils for Earthwork.

2.6 NOT USED

2.7 ACCESSORIES

A. Concrete for Thrust Restraints: As specified in Section 03 30 00 - Cast-in-Place Concrete.

B. Miscellaneous Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36 or ASTM A307.
2. Grade A carbon steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing utility water main size, location, and invert are as indicated on Drawings.

B. Inspection:

1. All pipe sections, specials, and jointing materials shall be carefully examined for defects.

2. No piping or related materials shall be laid that is known to be defective. Any defective piece installed shall be removed and replaced with a new pipe section in a manner satisfactory to the Owner's Representative at the Contractor's expense.

3. Defective material shall be marked and removed from the job site before the end of the day.

C. Pipe Cutting:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.

3. Grind edges smooth with beveled end for push-on connections.

4. Prior to assembly of field cut pipe, the reference mark shall be re-established with a pencil or crayon. The location of the reference mark at the proper distance from the bevel end shall be in accordance with the Manufacturer's recommendations.

D. Remove scale and dirt on inside and outside before assembly. Cleaning of each pipe or fitting shall be accomplished by swabbing out, brushing out, blowing out with compressed air, or washing to remove all foreign matter.

E. Prepare pipe connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Bedding:

1. Excavation:

a. Excavate pipe trench as specified in Section 31 23 17, Trenching for Work of this Section.

b. All pipe trenches shall be excavated below the proposed pipe invert as required to accommodate the depths of pipe bedding material as scheduled on the Drawings.

c. Remove large stones or other hard matter which could damage pipe or impede consistent pipe bedding backfilling or compaction.

d. Trench base shall be inspected prior to placement of pipe.

e. Hand trim excavation for accurate placement of pipe to elevations as indicated on Drawings.

2. Dewater excavation as specified in Section 31 23 19, Dewatering to maintain dry conditions and to preserve final grades at bottom of excavation.

3. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

4. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth and compact to 95 percent of maximum density.

B. Piping:

1. Install pipe according to AWWA C60 and AWWA C605.

2. Handle and assemble pipe according to Manufacturer instructions and as indicated on Drawings.

3. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

4. Steel Rods, Bolt, Lugs, and Brackets: Coat buried steel with one coat of coal tar coating before backfilling.

5. Sanitary Sewer Separation:

a. Install new water lines and appurtenances in compliance with local and state regulations governing the horizontal and vertical separations between water and sewer facilities.

b. Variance:

1) If a variance is proposed due to requested design revisions or if an existing facility has been installed at a different location or elevation than indicated on the Plans, submit written proposal for review and approval by the Owner's Representative.

2) Include the reason for the variance, type of material and condition of the sewer line, location of the water and sewer facilities, horizontal and vertical skin-to-skin clearances and corrective measures proposed.

3) Each variance will be considered on a case-by-case basis.

4) Review Time: Allow a minimum of 5 working days review and response to each proposal.

6. Install ductile iron fittings according to AWWA C600.

7. Joints:

   a. Pipe jointing surfaces shall be clean and dry when preparing surfaces for joining.

   b. Lubricants, primers, adhesives, etc. shall be used as recommended by the Pipe or Joint Manufacturer's specifications.

   c. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight joint.

   d. Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing.

   e. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of the pipe from any cause.

8. Flanged Joints: Not to be used in underground installations except within structures, unless shown otherwise in the Drawings.

9. Deflection:

   a. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly.

   b. Deflection by bending of the pipe rather than at the joints is not allowed.

   c. The maximum pipe deflection shall not exceed one-half of the Manufacturer's stated joint deflection allowance.

   d. Set a laser, string line, or other approved alignment guide along the centerline of previously installed pipe to the point where pipe joint deflection is required. The approved alignment guide shall extend to the end of the proposed subsequent pipe length. A measurement will be taken from the alignment guide to the centerline of the subsequent pipe length to determine the amount of

pipe joint deflection proposed. Measured deflection shall not exceed the specified allowable deflection for the purposes of aligning the pipe.

10. Install pipe and fittings to the line and grade specified on the Drawings, with joints centered, pipe properly supported and restrained against movement, and all valve stems plumb. Re-lay pipe that is out of alignment or grade.

11. High Points:

    a. Install pipe with no high points, unless otherwise shown in the Drawings.

    b. If unforeseen field conditions arise that necessitate high points, install air release valves as directed by Owner's Representative.

12. Bearing:

    a. Install pipe to have bearing along entire length of pipe.

    b. Excavate bell holes to permit proper joint installation where necessary or as directed by Owner's Representative.

    c. Do not lay pipe in wet or frozen trench.

13. Prevent foreign material from entering pipe during placement.

14. Install pipe to allow for expansion and contraction without stressing pipe or joints.

15. Close pipe openings with watertight plugs during Work stoppages.

16. All pipe ends which are to be permanently closed shall be plugged or capped and restrained against internal pressure.

17. Install access fittings to permit disinfection of water system performed under Section 33 13 00 – Testing and Disinfecting of Water Utility Piping.

18. Cover:

    a. Establish elevations of buried piping with not less than 36 inches of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.

C. Thrust Restraints:

1. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks at locations shown in the Drawings and as required to facilitate testing of lines.

2. Pour concrete thrust blocks against undisturbed earth.

3. Locate thrust blocks to ensure that pipe and fitting joints will be accessible for repair.

4. Provide thrust restraint bearing area on subsoil as shown in details within the Drawings.

5. Install tie rods, clamps, setscrew retainer glands, or restrained joints.

6. Protect metal-restrained joint components against corrosion with polyethylene film or wax tape as specified herein.

7. Avoid encasing mechanical and flanged joints in concrete. Provide clearance between concrete and mechanical and flange joints to allow future bolt removal.

D. Backfilling:

1. Backfill of piping systems shall be as specified in Section 31 23 17, Trenching.

E. Testing and Disinfection of Potable Water Piping System:

1. In accordance with AWWA C600, AWWA C605, and AWWA C651 and as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Piping.

2. All chlorinated water used in disinfection of the water main shall either be discharged through an approved connection to a public sanitary sewer system or shall be dechlorinated to limits acceptable by the Oregon State Department of Environmental Quality (DEQ) prior to discharge into any storm drainage system or open drainage way.

3. No chlorinated water shall be discharged into a storm drainage system or open drainage way without a dechlorination under a plan meeting DEQ's requirements.

3.3 FIELD QUALITY CONTROL

A. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

END OF SECTION

SECTION 33 12 16 - WATER UTILITY DISTRIBUTION AND TRANSMISSION VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes valves and valve boxes for installation with buried water distribution and transmission main, including fire hydrants and tapping sleeves.

B. Section Includes:

1. Valves.
2. Valve boxes.
3. Valve operator extensions.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

2. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy, and other Special Alloys

3. ASME 1.20.1 - General Purpose Pipe Threads (Inch)

B. American Water Works Association (AWWA):

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service

3. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants

4. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances

5. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

C. ASTM International (ASTM):

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications

D. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects
2. NSF 372 - Drinking Water System Components - Lead Content

1.3 COORDINATION

A. The Contractor shall cause the Supplier of valves to coordinate installation such that all pipes, valves, fittings, appurtenances, and equipment are compatible and capable of achieving the performance requirements specified in the Contract Documents.

B. Coordinate Work of this Section with City of Pendleton standards and utilities within construction area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit Manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling: Schedule of valves to be labeled indicating in each case the valve location and the proposed labeling for the valve.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.
B. Operation and Maintenance Data: Submit information for valves.

1.6 NOT USED

1.7 QUALITY ASSURANCE

A. Cast Manufacturer's name, maximum working pressure, size of valve, and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, American National Standards Institute (ANSI), ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.

E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Owner’s Representative.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves and accessories for shipment according to applicable AWWA standards.

B. Seal valve and ends to prevent entry of foreign matter.

C. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.

D. Storage:

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

E. Handle products carefully to prevent damage to interior or exterior surfaces.

F. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 RESILIENT WEDGE GATE VALVES

A. As specified in Section 40 05 23, Common Work Results for Process Valves.

B. Connecting Hardware:

1. As specified in Article 2.3, Nuts, Bolts and Washers of Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Gaskets:

1. As required for the end connection types specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

2.3 NOT USED

2.4 NOT USED

2.5 NOT USED ACTUATORS

A. Unless otherwise indicated, all valves shall be furnished with manual actuators.

B. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

C. All gear-assisted valves that are buried and submerged shall have the actuators hermetically sealed and grease-packed.

D. All valves 6 inches to 30 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

2.6 VALVE BOXES

A. Provide all buried valves with valve boxes, covers and risers.

B. Valve Boxes:

1. Materials: Cast iron.

2. Construction:

a. Walls not less than 3/16-inch thick at any point.
b. Internal diameter not less than 5 inches.

3. Type: Two-piece extension.

4. Manufacturers:

a. Olympic Foundry.
b. Brooks Products.

C. Covers:

1. Construction:

a. Prevents dislodging and rotation from traffic.
b. Allows a hand-held pry bar to be applied for easy removal.

2. Materials: Cast iron.

3. Lid Inscription: WATER.

4. Manufacturers: Matching that of valve box.

D. Riser:

1. Polyvinyl Chloride (PVC) Pipe:

a. ASTM D3034, SDR 35 PVC.
b. White, Schedule 40, 8-inch diameter.
c. Length as shown on details in the Drawings.

2.7 VALVE OPERATOR EXTENSIONS

A. As shown in the Drawings.

B. Provide operator extensions to a maximum of 12 inches below grade where depth to valve exceeds 36 inches.

2.8 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 03 30 00 - Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 PREPARATION

A. Conduct operations to not interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures, utilities, and landscape in immediate or adjacent areas.

B. Identify required lines, levels, contours, and datum locations.

C. Locate, identify, and protect from damage utilities to remain.

D. Access:

1. All valves shall be installed to provide easy access for operation, removal, and maintenance.

2. Avoid conflicts between valve operators and above grade construction such as structural members or handrails.

E. Valve Accessories:

1. Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly.

2. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.2 INSTALLATION

A. General:

1. All valves, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as shown in the Drawings and as specified herein.

2. Valves shall be firmly supported to avoid undue stresses on the pipe.

3. Stem extensions shall be braced at no greater than 10 feet intervals and be provided with double universal joints to allow for misalignment, where applicable.

B. Perform trench excavation, backfilling, and compaction as specified in Section 33 11 10, Water Utility Distribution and Transmission Piping.

C. Install valves in conjunction with pipe laying.

D. Set valves plumb.

E. Provide buried valves with valve boxes installed flush with finished grade.

1. Valves installed out of paved or otherwise hard-surfaced areas shall be set in a concrete pad at finished grade.

2. Concrete valve box pads shall be 18 inches square and be not less than 6 inches thick.

F. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfection of Water Utility Piping.

3.3 FIELD QUALITY CONTROL

A. Pressure test valving for water distribution system according to AWWA C600 and in accordance with Section 33 13 00, Testing and Disinfection of Water Utility Piping.

B. Field Testing of Valves:

1. All valves 18-inch diameter or larger shall be pressure and leakage tested at the Site and shall pass the field testing prior to installation.

2. Valves shall be tested at 1.5 times normal operating pressure, 200 pounds per square inch (psi) minimum.

3. No valve shall be accepted for installation that fails to pass the field pressure test. Any valves failing field pressure tests shall be replaced by the Contractor at no additional cost to the Owner.

4. Owner's Representative shall witness field testing.

END OF SECTION

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SECTION 33 13 00 - TESTING AND DISINFECTION OF WATER UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hydrostatic pressure testing, disinfection, and purity testing of potable water systems piping, fittings, valves, and domestic water services.

B. Section Includes:

1. Pressure testing and disinfection of potable water distribution and transmission piping systems and appurtenances.

2. Testing and reporting of results.

1.2 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

1. AWWA B300 - Hypochlorites
2. AWWA B301 - Liquid Chlorine
3. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
4. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings
5. AWWA C651 - Disinfecting Water Mains
6. AWWA C655 - Field Dechlorination

1.3 SUBMITTALS

A. Section 01 33 00 - Submittals Procedures: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Pipeline Testing and Disinfection Plan: To be submitted for review and approval by the Owner’s Representative a minimum of 1 month before testing is to start. As a minimum, the plan shall include the following:

1. Testing schedule.

2. Hydrostatic Testing Plan:

a. Narrative of the proposed process.
b. Proposed equipment to be used.

c. Disposal location for excess water used to fill mains.

3. Disinfection Plan:

a. Narrative of the proposed process.

b. Proposed chemicals and equipment (including list of all pumps and meters) to be used.

c. Calculations for the amount of chlorine required to achieve required chlorine residual levels.

d. Proposed method of mixing, injecting, and distributing of chlorine solution throughout all portions of the new water system facilities.

e. Proposed plan for testing chlorine levels throughout the length of pipeline.

4. Proposed testing locations.

5. Proposed plan for water conveyance, including flow rates.

6. Proposed plan for water control.

7. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.

8. Proposed measures to be incorporated in the Project to minimize erosion while discharging water from the pipeline.

1.4 CLOSEOUT SUBMITTALS

A. Disinfection Report:

1. Type and form of disinfectant used.

2. Date and time of disinfectant injection start and time of completion.

3. Test locations.

4. Name of person collecting samples.

5. Initial and 24-hour disinfectant residuals in treated water in parts-per million (ppm) for each outlet tested.

6. Date and time of flushing start and completion.

7. Disinfectant residual after flushing in ppm for each outlet tested.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Owner's Representative's review. No materials shall be used which would be injurious to the construction or its future functions.

B. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.

C. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Owner's Representative.
1	Hydraulic pump approved by the Owner's Representative with hoses, valves, and fittings as needed and required for the testing and disinfection of the facilities.
1	High range chlorine test kit, as approved by Owner's Representative, with digital readout. Range of detection shall be between 5 and 200 ppm. Accuracy of 3 percent.
2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in 2 pounds per square inch (psi) increments. Gauges shall have been calibrated with 90 days of pressure testing.

2.2 DISINFECTION CHEMICALS

A. Chemicals:

1. Hypochlorite: Comply with AWWA B300.
2. Liquid chlorine: Comply with AWWA B301.

2.3 DECHLORINATION CHEMICALS

A. Chemicals:

1. Comply with AWWA C655.

PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF WATER PIPING

A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.

B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted, and passed required density testing and all field-placed concrete or mortar has attained full strength.

1. At the Contractor's option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.

2. All such substitutions and installations shall be approved by the Owner's Representative prior to installation.

C. Provide 72-hour notification to the Owner's Representative and Owner prior to conducting hydrostatic testing.

1. Provide coordination and scheduling required for the Owner and Owner's Representative to witness and provide necessary labor for operating Owner's existing system during hydrostatic testing and disinfecting procedures.

2. The Contractor shall not operate any part of the existing water systems.

D. Pipe Filling:

1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.

2. Take all required precautions to prevent entrapping air in the pipes.

3. Allow for natural absorption of water by the lining of the pipe to occur.

4. Apply specified test pressure by pumping.

E. Testing of Mains:

1. Ductile Iron: In accordance with AWWA C600.

2. Polyvinyl chloride (PVC): In accordance with AWWA C605.

3. General:

a. Tests shall be conducted under a hydrostatic test pressure not less than 1.25 times the stated anticipated maximum sustained working pressure of the

pipeline measured at the highest elevation along the test section and not less than 1.5 times the stated working pressure at the lowest elevation of the test section, minimum 200 psi, unless otherwise shown in the Drawings.

b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.

c. Testing shall be performed by applying the specified test pressure by pumping.

d. Once the test pressure has been attained, the pump shall be valved off.

e. The test will be conducted for a 2-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.

f. During the test period, there shall be no appreciable or abrupt loss in pressure.

4. Allowable Leakage:

a. Flanged Joints: Pipe, fittings, and valves with flanged joints shall be completely watertight. No leakage allowed.

b. Mechanical or Push-on Joints: Pipe, fittings, and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{ND(P)^{1/2}}{11{,}000}$$

In the above formula:

AL = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipeline installed
D = Nominal diameter of pipe, in inches
P = Average test pressure during the leakage test, in pounds per square inch.

5. Maintaining Pressure:

a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

b. At the end of test period, operate the pump until the specified test pressure is again obtained.

1) The pump suction shall be in a clean, graduated barrel, or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.

2) Sterilize this makeup water by adding chlorine to a concentration of 25 milligrams per liter (mg/L).

c. The Owner's Representative will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.

d. Each hour's loss stands on its own and will not be averaged.

6. Defects, Leakage, Failure:

a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment, and materials required to locate and make necessary repairs.

b. Correct any visible leakage regardless of the allowable leakage specified above.

c. All leaks shall be repaired in a manner acceptable to the Owner's Representative.

d. The testing of the line shall be repeated until a test satisfactory to the Owner's Representative has been achieved.

3.2 DISINFECTION OF WATER PIPING

A. Disinfection shall be in accordance with the latest version of AWWA C651 following Owner's Representative's acceptance of hydrostatic testing.

B. Chlorination by means of tablets or powders (calcium hypochlorite) placed in each length of pipe during installation is specifically prohibited.

C. Flush all foreign matter from the pipeline, branches, and services.

1. Provide at no additional cost to the Owner, hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

2. Flushing velocities shall be at least 2.5 feet per second (fps).

3. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipe in place from the inside by brushing and sweeping, then flush the line at a lower velocity.

D. Chlorine Application:

1. Fill the test section of main from the lowest elevation and maintain a steady flow rate while injecting the water main with chlorinated water.

2. Flow (bleed) a blow-off, standpipe or hydrant at the water main's high point(s) to allow air to escape and ensure all interior pipe surfaces are wetted.

E. Chlorine Residual:

1. Measure chlorine residual with a high-range chlorine test kit at a point near to the injection point while filling the main.

2. Adjust the dose rate as necessary to maintain the target dose rate.

F. Potable water piping shall be disinfected with a solution containing a minimum 25 ppm and a maximum 50 ppm chlorine.

1. Once the main is completely filled with super-chlorinated water, measure the chlorine residual a minimum of once every 200 feet of main and once for each main branch, 2-inch service, or as directed by the Owner's Representative.

2. The chlorine solution shall remain in the piping system for a period of 24 hours, after which time the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

3. If check samples fail to produce acceptable results, the disinfection procedure shall be repeated at the expense of the Contractor until satisfactory results are obtained.

G. Flush piping, branches, and services with municipal potable water until the chlorine residual is below 1.5 ppm and approximately the same as the source water.

1. There is no minimum flushing velocity for this step.

H. Disposal of any water containing chlorine shall be performed in accordance with the latest edition of AWWA C651 and C655, and all state or local requirements.

1. Disposal may be made into existing sanitary sewer systems providing approvals are obtained from the respective system owners.

2. Any chlorinated water discharged to open stream channels must be dechlorinated prior to discharge to levels acceptable by Oregon State Department of Environmental Quality (DEQ).

3.3 DISINFECTION AND TESTING OF WATER MAIN END CONNECTIONS AND TIE-INS

A. Disinfection of potable water piping and appurtenances at end connections and tie-ins to the existing system which are required to remain in service due to restrictions in allowable shutdown time shall be disinfected as described below.

B. Prior to connecting new potable water piping and appurtenances with existing piping and appurtenances, the interior of all new pipe, fittings, valves, and appurtenances shall be swabbed or sprayed with a 1 percent to 5 percent calcium hypochlorite solution.

C. In accordance with AWWA C651, swabbing or spraying of connection piping is allowed only if the total length of piping is equal to or less than one pipe length (18 feet). All runs of new piping over 18 feet in total length will require hydrostatic pressure testing, flushing and disinfection as detailed elsewhere in this Section.

D. Following the disinfection procedures described above, connection of the new piping and appurtenances to the existing water system shall be made.

1. During the system startup, the Owner's Representative and Contractor shall visually inspect all new fittings, piping, valves, and appurtenances for evidence of leakage.

2. Any leakage observed during this period shall be promptly repaired by the Contractor, at Contractor's expense, as required by the Owner's Representative.

3.4 FIELD QUALITY CONTROL

A. Bacteriological Sampling and Testing:

1. The Owner will collect samples after the line is flushed in accordance with the latest edition of AWWA C651.

   a. The locations for sample collection shall be at the sole discretion of the Owner and Owner's Representative.

   b. The chlorine residual must be below 1.5 ppm or restored to the level maintained in the Owner's distribution system, when the sample is taken.

2. Bacterial Testing: After completing the chlorination procedure, test the main according to the following:

   a. Bacterial Sampling

      1) Option A:

a) Take an initial set of samples using sampling site procedures outlined herein.

b) Resample after a minimum of 24 hours' time has elapsed using sampling site procedures outlined herein.

c) Both sets of successive samples must pass for the main to be approved for service.

2) Option B:

a) Allow main to sit for a minimum of 24 hours without any water use.

b) Using sampling site procedures outlined herein, collect two sets of samples a minimum of 15 minutes apart while the sampling taps are left running.

c) Both sets of samples must pass for the main to be approved for service.

3) Allow 24 hours for the test results for each sample set.

b. Sampling Locations

1) The Owner will take one bacteriological sample from the end of the main and on each branch.

2) For long runs of main, at least one sample will be taken for every 1,200 feet of new main and as directed.

c. Sample Testing

1) The Owner will test the sample set for coliform bacteria and publish the test results within 24 hours.

d. Evaluating the Test Results

1) If one or more of the sample set tests positive for coliforms (fails), repeat chlorination and sampling processes specified herein after correcting the cause of the failure and as directed by the Owner's Representative.

2) When two consecutive sample sets test negative (passing) for coliform bacteria, the bacterial testing is complete.

e. Completion of Bacterial Testing

1) Upon completion of bacterial testing, the Owner shall notify the Owner's Representative and Contractor in writing that the testing is complete and the main is ready for tie-in.

f. Multiple Positive (Failing) Test Results

1) If sample sets continue to test positive for coliforms, the Owner's Representative will determine how to proceed, up to and including repeating the chlorination procedure or rejecting the pipe.

3. Results of the bacteriological testing shall be satisfactory with the Oregon Health Authority and/or other appropriate regulatory agencies, or disinfection shall be repeated by the Contractor.

B. Optional Sampling and Testing

1. If a pipeline is not promptly returned to service, the situation will be evaluated by the Owner to determine if the water quality may have been impacted and if additional testing as specified herein is warranted.

END OF SECTION

SECTION 33 41 10 - STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.

B. Section includes:

1. Storm drainage piping.
2. Piping accessories
3. Connection to existing manholes.
4. Catch basins and area drains.
5. Cleanouts.
6. Bedding and cover materials.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-pound) Rammer and a 305-mm (12-inch.) Drop.

2. AASHTO M294 – Standard Specification for Geosynthetic specification for Highway Applications.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.

6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

8. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

12. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

13. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

15. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

16. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

18. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association:

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inch Through 12 Inch (100 mm Through 300 mm), for Water Transmission and Distribution.

1.3 COORDINATION

A. Notify affected utility companies at least 72 hours prior to construction.

1.4 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:

1. Indicate special procedures required to install specified products.
2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture, dust and direct sunlight by storing in clean, dry location remote from construction operations areas.

2. Block individual and stockpiled pipe lengths to prevent moving.

3. Provide additional protection according to manufacturer instructions.

1.7 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe: NOT USED

B. Ductile Iron Pipe: NOT USED

C. High Density Polyethylene (HDPE) Pipe:

1. Double wall, ribbed pipe with smooth interior.

2. Solid pipe, perforated pipe, and fittings shall meet the requirements of ASTM F 405 and F 667

3. Pipe 3 inches to 10 inches in diameter: Comply with AASHTO M 252.

4. Pipe 12 inches to 60 inches in diameter: Comply with AASHTO M 294.

5. Joints: Integral bell push-on type.

6. Manufacturers:

a. ADS, N-12 with ProLink joints, or equal.

D. Acrylonitrile-Butadiene-Styrene (ABS) Pipe: NOT USED

E. Reinforced Concrete Pipe: NOT USED

2.2 FLEXIBLE COUPLINGS

A. Description:

1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Ethylene propylene rubber (EPDM).
2. Comply with ASTM C923.
3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

A. Concrete:

1. As specified in Section 03 11 00, Concrete Work.
2. Strength: Minimum 3,000 psi at 28 days.
3. Air entrained.
4. Finish: Rough troweled.

B. Concrete Reinforcement: As specified in Section 03 11 00, Concrete Work.

2.5 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced precast concrete pipe sections.

a. Minimum compressive strength of 3,000 psi at 28 days.
b. Precast concrete inlets shall conform to ASTM C913.

2. Joints: Lipped male/female.

3. Nominal Interior Dimensions: As shown in the Drawings.

B. Cover and Frames:

1. Materials: Cast iron.

2. Lid:

a. Domed Beehive Grate.

b. Removable.

3. Nominal Lid and Frame Size: As shown in the Drawings.

2.6 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.7 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

3. Trench Backfill from Pipe Zone to Finish Grade:

a. Material type varies by location, as shown in the Drawings.
b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

c. Subsoil Fill Type S1, as specified in Section 31 05 13, Soils for Earthwork.

2.8 MIXES

A. Grout: As specified in Section 03 60 00, Grouting.

2.9 ACCESSORIES

A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut or excavation base is ready to receive Work.
B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation in accordance with Section 31 23 17, Trenching.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Owner's Representative if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.

2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.

3. Pipe base shall be observed by Owner's Representative prior to placement of the pipe.

4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.

5. Provide sheeting and shoring as specified in Section 31 23 17, Trenching.

6. Placement:

a. Place bedding material at trench bottom.
b. Level materials in continuous layer not exceeding 6 inches compacted depth.
c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.

a. PVC, HDPE, ABS: Comply with ASTM D2321.

2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

3. Lay pipe to slope gradients and line as indicated on Drawings.

4. Variations:

    a. Maximum Variation from Indicated Line: 1/32 inch per inch of pipe diameter, but no more than 1/2 inch, providing that such variation does not result in a level or reverse-sloping invert.

    b. Maximum Variation from Indicated Grade: 1/32 inch per inch of pipe diameter, but no more than1/4-inch.

    c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64 inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.

6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Owner's Representative.

7. Make straight field cuts without chipping or cracking pipe.

8. Keep pipe and fittings clean until Work has been completed and accepted by Owner's Representative.

9. Assemble pipe joints in accordance with manufacturer's recommendations / specifications.

10. Cap open ends during periods of Work stoppage.

11. Lay bell and spigot pipe with bells upstream.

12. Backfill and compact as specified in Section 31 23 17, Trenching.

13. Do not displace or damage pipe when compacting.

14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.

2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.

3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.

4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.

5. The pipe is then forced “home” firmly and fully.

6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.

2. Use standard fittings of same material and joint type as sewer main.

3. Maintain minimum 5-foot separation distance between wye connection and manhole.

4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.

5. Mount saddles with solvent cement or gasket and secure with metal bands.

6. Lay out holes with template and cut holes with mechanical cutter.

E. Catch Basins

1. Form bottom of excavation clean and smooth, and to indicated elevation.

2. Mount lid and frame level in grout, secured to top cone section to indicated elevation.

F. Backfilling:

1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.

2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

A. Request inspection by Owner’s Representative prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

2. Pipe Testing: As specified in Section 33 01 30.13, Storm and Manhole Testing.

3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

This Section applies to the furnishing and installation of piping inside a building, structure, enclosure piping and miscellaneous yard piping.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B1.20.1 Pipe Threads, General Purpose (inch)
2. ASME A13.1 - Scheme for the Identification of Piping Systems.
3. ASME B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy, and other Special Alloys
4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.
5. ASME B31.3 - Process Piping.
6. ASME B31.9 - Building Services Piping.

B. ASTM International (ASTM):

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile.
3. ASTM A325 - Specification for High-Strength Bolts for Structural Steel Joints.
4. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
7. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement.
8. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

10. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

11. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.

12. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

C. American Water Works Association (AWWA):

1. AWWA C200 - Steel Water Pipe - 6 In. (150 mm) and Larger.

2. AWWA C207 - Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.

3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

5. AWWA C510 - Double Check Valve Backflow Prevention Assembly.

6. AWWA C511 - Reduced-Pressure Principal Backflow Prevention Assembly.

7. AWWA C606 - Grooved and Shouldered Joints.

8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

D. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code.

E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

F. NSF International (NSF):

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.4 COORDINATION

A. Coordinate installation of specified items with installation of valves and equipment.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit Manufacturer catalog information for each product specified.

C. Shop Drawings:

1. Identification:

a. Submit list of wording, symbols, letter size, and color coding for pipe identification.

b. Comply with ASME A13.1.

2. Provide all necessary dimensions and details on pipe joints, restraints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists.

3. Provide detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, couplings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

D. Manufacturer's Statement: Certifying pipe fabrication and products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS and ASME qualification within previous 12 months.

F. Manufacturer Instructions: Submit special procedures and setting dimensions.

G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping appurtenances.

B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Drawings:

1. Piping layouts shown in the Drawings are intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture of the pipe, the Owner's Representative shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Welding:

1. All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1.

2. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot, and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welders:

1. Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding.

2. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local approved testing agency prior to commencing work on the pipeline.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. The Contractor shall furnish all material and bear the expense of qualifying welders.

E. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

1.8 MATERIAL DELIVERY, STORAGE, AND INSPECTION

A. Inspection:

1. Accept materials on Site in Manufacturer's original packaging and inspect for damage.

2. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition.

B. Storage:

1. Store materials according to Manufacturer instructions.

2. Store materials off the ground, to provide protection against oxidation caused by ground contact

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.

3. Provide additional protection according to Manufacturer instructions.

D. All defective or damaged materials shall be replaced with new materials.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 DUCTILE IRON PIPE AND FITTINGS

A. Centrifugally cast, conforming to AWWA C151 and AWWA Standard C115.

B. Coating: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Painting and Coatings.

C. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.

D. Pipe Thickness Class:

1. Comply with AWWA C115.

2. Class 52, unless shown to be greater in the Plans.

3. Flanged Joints:

a. Flat faced, complying with AWWA C111 and C115, unless otherwise specified.

b. Bolt hole drilling according to ASME/ANSI B16.1, Class 125, or ASME/ANSI B16.1, Class 250, where specified. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.

c. The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain mating pipe, valve, and fitting flanges match in bolt pattern.

d. Flange joint connections shall not be exposed to test pressures greater than 1-1/2 times their rated working pressure.

e. Gaskets:

1) Full faced, composed of neoprene rubber, 55-65 durometer hardness, 1/8-inch thick. Dimensions shall be per ANSI B16.21.

2) Ring gaskets shall not be permitted.

E. FITTINGS:

1. Material: Ductile iron, complying with AWWA Standard C110.

a. Fittings conforming to AWWA C153 may be substituted in lieu of AWWA C110 fittings.

b. Fittings shall be flanged as required and shown on the Drawings.

c. All restraint systems and flanged fittings shall be provided with bolts and gaskets as specified herein.

2. Coating and Lining:

a. Coating: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Painting and Coatings

b. Cement Mortar Lining: Comply with AWWA C104,

3. Following information cast upon fittings:

a. Manufacturer's identification.
b. Country of manufacture.
c. Pressure rating.
d. For bends, number of degrees and/or fractions of a circle.

F. NUTS, BOLTS, AND WASHERS:

1. All bolts shall have heavy hex head with heavy hex nuts.

a. Bolts: Low-carbon steel composition. Comply with ASTM A307, Grade B.
b. Nuts: Comply with ASTM A563A, Heavy Hex.
c. Washers: Comply with ASTM F844.

2.3 COPPER PIPE AND FITTINGS

A. Description:

1. Seamless; ASTM B88.

2. Type:

    a. Type L, hard drawn.

    b. For pipe under floor slabs, underground or cast in concrete: Type K, annealed, seamless.

B. Joints:

1. Compression or soldered

C. Dissimilar Metals: See Dielectric Unions specified herein.

2.4 BRASS PIPE AND FITTINGS

A. Pipe: ASTM B43, chrome plated.

B. Fittings:

1. ASTM B584, brass.
2. ASTM B16.15.

C. Joints:

1. Mechanical compression.
2. Threaded: Tapered and smooth threads, ASME B1.20.1 and ASTM B43.

D. Dissimilar Metals: See Dielectric Unions specified herein.

2.5 STAINLESS STEEL TUBING AND FITTINGS

A. Type 316 stainless steel, unless otherwise specified or shown in the Plans.

B. Meet the material standards set forth in ASTM A269.

C. Fittings: ASTM A276 and ASTM A182.

1. Threaded fittings: National pipe thread meeting the requirements of ASME B1.20.1.
2. Compression fittings: Two-ferrule, mechanical grip design.

D. Unions: Provide to facilitate installation and maintenance of tubing.

2.6 RESTRAINED FLANGE ADAPTERS FOR DUCTILE IRON PIPE

A. Description:

1. ASTM A536, ductile iron.

2. Flange bolt circles compatible with ANSI/AWWA C115/A21.15.

3. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.

4. Capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

5. Manufacturer:

    a. EBAA Iron, Series 2100 Megaflange or equal.

2.7 INSULATING UNION

A. Description:

1. Material: Galvanized malleable iron with a ground joint.

2. Iron pipe threads: Conform to ANSI B2.1.

3. Insulations: Nylon, bonded, and molded onto the metal body.

4. Union: Rated for the operating and test pressures of the pipe system.

5. Joint connections to copper alloy pipe and tube shall be copper solder or threaded brass ground joints.

6. Isolation Barrier: Impervious to water.

2.8 BACKFLOW PREVENTERS

2.9 DISMANTLING JOINT

A. Description:

1. Comply with AWWA C219, where applicable.

2. Self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust.

3. Design: No part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.

4. Dismantling joints will allow for a minimum of 2 inches of longitudinal adjustment.

5. Furnish as a complete assembly consisting of spigot piece, flange adaptor, tie bars, and gasket.

6. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie Rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The Tie Rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50 percent of the yield strength of tie rod material.

7. Pressure Rating:

    a. Determined by the flange configuration, and all commonly used flanges shall be available.

    b. Design pressure rating shall be equal to or greater than the mating flanges.

    c. Dismantling joints will be specially fabricated to accommodate pressure requirements with ANSI B16.5 or ANSI B16.47 300-pound class flanges, depending on size of dismantling joint.

8. Lining and Coating:

    a. Shop-applied fusion bonded epoxy coating applied by fluidized bed method, complying with the requirements of NSF 61 and AWWA C550 as applicable.

    b. As an alternative, a shop-coat primer suitable for field applied coatings can be supplied.

9. Flanges: Flat-faced, rated to pressure requirements as shown on the Drawings.

    a. Where design pressure is greater than 300 psi, flanges shall conform to ASME B16.5 and ASME B16.47 300-pound class.

B. Materials:

1. Spigot piece: Steel, ASTM A283 Grade C.

2. Flange adaptor:

    a. Up to 12-inch diameter: Ductile iron, ASTM A536 Grade 65-45-12.
    b. Above 12-inch diameter: Steel, ASTM A283 Grade C.

3. Tie bars: ASTM A193 Grade B7 threaded rod with rolled threads.

4. Gasket: EPDM Grade E.

5. Nuts, Bolts, and Washers: Type 304 stainless steel.

C. Manufacturer:

1. Romac or equal.

2.10 PIPE SUPPORTS

A. Floor Support for Pipe:

1. Flanged Pipe Support:

a. Construction:

1) Adjustable vertical pipe support, flange plate, extension pipe from base cup to top collar cup with threaded stud.

2) Bolts directly to flange.

3) Anchorable base plate.

b. Material: Steel, comply with ASTM A36.

c. Finish: Corrosion resistant, electro-galvanized, or prime coated.

d. Manufacturers:

1) Standon - Model S89.

2. Cradle Pipe Support:

a. Construction:

1) Adjustable vertical pipe support with saddle strap, extension pipe from base cup to top collar cup with threaded stud.

2) Anchorable base plate.

b. Material: Steel, comply with ASTM A36.

c. Finish: Corrosion resistant, electro-galvanized, or prime coated.

d. Manufacturers:

1) Standon - Model S92.

2.11 PIPE COATINGS

A. See Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.1 GENERAL

A. Furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill, and encasement, to provide a functional installation.

B. Pipe shall be installed in accordance with good trade practice. The methods employed in handling and placing of pipe, fittings, and equipment shall be such as to insure that after installation and testing they are in good condition. Should damage occur to the pipe, fitting or equipment, repairs satisfactory to the Owner's Representative shall be made.

3.2 INSTALLATION

A. Buried Piping Systems:

1. Establish elevations of buried piping with not less than 3 feet of cover.

2. Remove scale and dirt from inside of piping before assembly, as may be required.

3. Excavate pipe trench as specified in Section 31 23 17, Trenching.

4. Install pipe to accurate lines, elevations, and grades as shown on the Drawings.

5. Where grades are not shown, pipe shall be laid to grade between control elevations shown on the Drawings.

6. Place bedding material at trench bottom to provide uniform bedding for piping.

7. Level bedding material in one continuous layer not exceeding 6 inches compacted depth.

8. Install pipe on prepared bedding.

9. Route pipe in straight line.

10. Install pipe to allow for expansion and contraction without stressing of pipe or joints.

11. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

12. Pipe Cover and Backfilling:

a. Backfill trench as specified in Section 31 23 17, Trenching.

13. All buried non-ferrous piping shall be installed with detectable tracer tape.

a. Tape shall be buried 12 inches above the top of the pipe or as recommended by Manufacturer.

b. Tape shall be continuous and labeled the same as the piping system.

B. Interior Piping Systems:

1. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as specified in Section 09 90 00, Painting and Coating.

2. Install water piping according to ASME B31.9.

3. Install brass male adapters each side of valves in copper piped system, solder adapters to pipe.

C. Pipe Supports and Hangers

1. Install pipe supports according to MSS SP-58 and ASME B31.10.

2. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of pump casings or equipment.

3. Special hangers and supports are shown on the Drawings.

4. The Contractor shall be responsible for determining the location of and providing all additional supports.

5. Hanger supports shall be as noted below with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Sufficient hangers shall be provided to maintain proper slope without sagging. Support spacing shall not exceed Manufacturer's recommendations, nor as listed below.

Pipe	Maximum Support Spacing (Feet)
Steel Pipe	
Under 3 inches	6
3 inches and Over	12
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	12
Stainless Steel and Galvanized Iron	
Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6
PVC Pipe	
Under 2-1/2 inches	4
2-1/2 inches and Over	6

6. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the weight of the piping and contents unless other vertical support is shown, but in no case shall be more than 12 feet.

7. Provide adjustable hangers for all pipes, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and guide where required, as well as support piping. All rigid hangers shall provide a means of vertical adjustment after erection. Hanger rods shall be machine threaded. Continuous threaded rods will not be allowed.

8. Clevis or band-type hangers (B-Line FIG B3100) or equal shall be provided as required. Strap hangers not permitted.

9. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which cannot be properly supported or suspended by the walls or floors. Pipelines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

10. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

11. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

D. Pipe Penetrations:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals or grout, as shown in the Drawings.

3.3 CLEANING, TESTING, AND DISINFECTION

A. Testing and Disinfection: Piping shall be hydrostatically tested, flushed, and disinfected as specified in Section 33 13 00, Testing and Disinfection of Water Utility Piping.

END OF SECTION

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SECTION 40 05 23 - COMMON WORK RESULTS FOR PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes basic materials and methods related to valves commonly used for process systems, including pump stations, utility vaults and water & wastewater treatment.

B. Section Includes:

1. Valves.
2. Valve actuators.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

3. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.

4. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

5. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association:

1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.

2. Submit valve cavitation limits.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.

E. Lining and coating data.

F. Valve Labeling Schedule: Indicate valve locations and nametag text.

G. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

J. CLOSEOUT SUBMITTALS

1. Project Record Documents: Record actual locations of valves and actuators.
2. Operation and Maintenance Data: Submit information for valves.

K. MAINTENANCE MATERIAL SUBMITTALS

1. Spare Parts:

    a. Furnish one set of manufacturer's recommended spare parts.

2. Tools:

    a. Furnish special wrenches and other devices required for Owner to maintain equipment.

    b. Furnish compatible and appropriately labeled toolbox when requested by Owner.

1.5 QUALITY ASSURANCE

A. Cast manufacturer's name, pressure rating, size of valve and year of fabrication into valve body.

B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.

C. Certification: Prior to shipment, submit for all valves over 12 inches in diameter, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc. Valves tested and supplied shall be trackable and traceable by serial number, tagged or otherwise noted on valve, upon arrival to Site.

D. Maintain clearances as indicated on Drawings.

E. Unless otherwise noted, all water works materials provided for the Project shall be new, of first class quality and shall be made by reputable manufacturers.

F. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

1. Store materials in areas protected from weather, moisture, or other potential damage.

2. Do not store materials directly on ground.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.

3. Provide additional protection according to manufacturer instructions.

D. Handle products carefully to prevent damage to interior or exterior surfaces.

E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.

1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.

2. All brass in contact with potable water shall comply with ASTM B584.

2.2 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required and shown in the Drawings.

B. Operation:

1. Open by turning counterclockwise; close by turning clockwise.

2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

C. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.

2.3 RESILIENT-SEATED GATE VALVES (V-500)

A. Description:

1. Comply with AWWA C509.

2. Minimum Pressure Rating:

a. Twelve-inch Diameter and Smaller: 200 pounds per square inch (gauge) (psig).
b. Sixteen-inch Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

a. Standard mechanical joint ends comply with ANSI/AWWA C111.

b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 & ASME 16.5.

1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C509 for manual valves.

5. Linings and Coatings:

a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

b. All internal and external ferrous surfaces.

c. Do not coat flange faces of valves.

6. Bi-directional flow.

B. Operation:

1. Non-rising stem.

2. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators. Unless specified or shown otherwise.

C. Materials:

1. Wedge:

    a. ASTM A126, cast iron or ASTM A536, ductile iron.
    b. Fully encapsulated with molded rubber.

2. Body and Bonnet:

    a. ASTM A126, cast iron or ASTM A536, ductile iron.

3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.

4. Valve Body Bolting: Stainless steel.

D. Manufacturers:

1. Clow Valve Company.
2. M&H Valve.
3. U.S. Pipe.
4. American Flow Control.
5. Mueller Company.
6. Or approved equal.

2.4 RUBBER-SEATED BUTTERFLY VALVES (V-100)

A. Description:

1. Comply with AWWA C504, Class 150B and 250B as indicated in the Drawings.

2. Minimum Pressure Rating:

    a. Twelve-inch (300-millimeter) Diameter and Smaller: 200 pounds per square inch (gauge) (psig).

    b. Sixteen-inch (400-millimeter) Diameter and Larger: 150 psig.

3. End Connections: As shown in the Drawings.

    a. Standard mechanical joint ends comply with ANSI/AWWA C111.

    b. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125, unless shown otherwise. Comply with AWWA C115 & ASME 16.5.

        1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

4. Gear Actuators: Conforming to AWWA C504 for manual valves.

5. Linings and Coatings:

    a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.

    b. All internal and external ferrous surfaces.

    c. Do not coat flange faces of valves.

6. Bubble-tight at the rated pressure for bi-directional flow.

7. Shaft: Self-lubricating, sleeve-type bearings. One-piece, through-shaft construction.

    a. Valve shafts shall be full size for that portion of the shaft extending through the valve bearings, valve disc, and shaft seal.

    b. Any portion of the shaft turned down for any reason shall have fillets with radii equal to the offset to minimize stress concentrations at the junction of the different shaft diameters. The turned down portion of the shaft shall be capable of transmitting the maximum operator torque without exceeding a torsional steel stress of 11,500 pounds per square inch (psi).

8. Seats: Mounted on body for valves 24 inches and smaller; field replaceable (mechanically retained in a machined groove) for valves larger than 24 inches.

9. Packing: Replaceable without dismantling valve.

B. Operation:

1. Open counterclockwise, unless otherwise indicated in the Drawings.

2. Operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering.

3. Buried Valves: All buried valves shall be provided with 2-inch square operating nuts.

4. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified or shown.

C. Materials:

1. Body: ASTM A126, cast iron or ASTM A536, ductile iron. Integrally cast flanged or mechanical end joints.

2. Shaft: Stainless steel.

3. Disc: ASTM A126, cast iron or ASTM A536, ductile iron.

4. Seats: Resilient, replaceable, Buna-N.

5. Seating Surfaces: Type 316 stainless steel.

6. Bearings:

    a. Sleeve: Corrosion-resistant and self-lubricating.

D. Manufacturers:

1. M&H Valve.
2. Henry Pratt Company.
3. Mueller Company.
4. Kennedy Valve Company.
5. Dezurik.
6. Val-Matic Valve & Manufacturing Corporation.
7. Or approved equal.

2.5 SILENT CHECK VALVES (V-403)

A. Description:

1. Type: Globe-style, silent operating type that begins to close as the forward velocity diminishes and be fully closed at zero velocity, preventing flow reversal and resultant water hammer or shock.

2. Valve design shall incorporate a center-guided, spring-loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe.

3. Valve Interior: Contoured and unrestricted to achieve maximum flow capacity along with minimum pressure drop.

4. Installation: Operation of the valve shall not be affected by the position of installation. It shall be capable of operating in the horizontal or vertical position with the flow op or down.

5. Valve Disc: Concave to the flow direction providing for disc stabilization, maximum strength, and minimal flow velocity to fully open the valve.

6. All component parts shall be field replaceable without the need of special tools.

7. A replaceable guide bushing shall be provided and held in position by the valve's spring.

8. Spring: Designed to withstand 100,000 cycles without failure and exert a force which allows the valve to start opening at a differential pressure of .5 pounds per square inch (psi) (.04 kilograms per square centimeter (kg/cm2)) and to fully open at a flow velocity of 4 feet per second (1.22 meters per second).

9. The valve disc and seat shall be field replaceable and have a seating surface finish of 32 micro-inch or better to insure positive seating at all pressures.

10. Valve shall be hydrostatically tested at 1.5 times the rated working pressure.

11. Working Pressure: 150 psi as indicated on Drawings.

12. End Connections: As shown on Drawings

    a. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125, unless shown otherwise. Comply with AWWA C115 & ASME 16.5.

        1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.

B. Materials:

1. Body: ASTM A536, ductile iron.
2. Trim: Stainless steel.
3. Spring: Stainless steel.
4. Resilient Seat: Buna-N

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C210.

2. For potable water service, epoxy lining and coating shall meet be provided with NSF 61 certification.

D. Manufacturer:

1. Val-Matic
2. Cla-Val
3. Approved equal.

2.6 SOLENOID VALVES (V-1200)

A. Description:

1. Coil: Continuous duty.
2. Operation: Fail open, energize to close.
3. Electrical Characteristics: 24 V DC or as indicated on the drawings.

4. End Connections: threaded
5. Conduit Connection: threaded

B. Materials:

1. Body: Brass.

2. Trim and Spring: Stainless steel.

2.7 COMBINATION AIR/VACUUM VALVES (V-800)

A. Description:

1. Ductile iron body and cover. Comply with ASTM A536.
2. Stainless steel orifice and float. Comply with ASTM A240.
3. Valves seats: Buna-N.

B. Manufacturers:

1. DeZurik - APCO
2. Or approved equal

2.8 BALL VALVES, 2 INCHES AND UNDER (V-200)

A. Description:

1. Four hundred-pound. Water, oil, and gas rating (WOG) with bronze body and trim, unless otherwise shown on the Drawings.

2. Seat ring: Tetrafluoroethylene (TFE).

3. O-ring seals: Fluorocarbon.

4. Three-piece construction so that maintenance can be performed without distributing the valve body after installation.

B. Manufacturer:

1. Nibco T-590-Y
2. or equal.

2.9 DOUBLE CHECK VALVE BACKFLOW PREVENTER ASSEMBLIES (V-900)

A. Size: 2-1/2 inches to 10 inches.
B. Comply with AWWA C510.

C. Materials:

1. Heavy-duty cast iron.
2. Finish: Fusion epoxy coating inside and outside.
3. Springs: Stainless steel.

D. Check Valves:

1. Quantity: Two, operating independently.

E. Manufacturer

1. Watts
2. Or equal

2.10 VALVE ACTUATORS

A. All valves shall be furnished with manual actuators, unless otherwise indicated in the Drawings.

B. Valves in sizes up to and including four inches in diameter shall have direct acting lever or handwheel actuators of the manufacturer's best standard design.

C. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.

D. Provide actuators with position indicators for shutoff valves 6 inches and larger.

E. Comply with AWWA C541 and C542, where applicable.

F. Furnish gear operators for valves 8 inches and larger, and chainwheel operators for valves mounted over 7 feet above floor.

G. Provide gear and power actuators with position indicators.

H. Gear-Assisted Manual Actuators:

1. Provide totally enclosed gears.

2. Maximum Operating Force: 60 lbf.

3. Bearings: Permanently lubricated bronze.

4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

I. Handwheel:

1. Furnish permanently attached handwheel for emergency manual operation.

2. Rotation: None during powered operation.

3. Permanently affix directional arrow and cast OPEN or CLOSE on handwheel to indicate appropriate direction to turn handwheel.

4. Maximum Operating Force: 60 lbf.

2.11 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 PREPARATION

A. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.

B. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

3.3 INSTALLATION

A. Install valves, actuators, extensions, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds of slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install valves with clearance for installation of insulation and allowing access.

G. Provide access where valves and fittings are not accessible.

H. Comply with Division 40 - Process Integration for piping materials applying to various system types.

I. Valve Applications:

1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.

2. Install shutoff and isolation valves.

3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.

4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

J. Disinfection of Water Piping System:

1. Flush and disinfect system as specified in Section 33 13 00, Testing and Disinfecting of Water Utility Distribution.

3.4 FIELD QUALITY CONTROL

A. Valve Field Testing:

1. Test for proper alignment.

2. If specified by valve Section, field test equipment to demonstrate operation without undue leakage, noise, vibration, or overheating.

3. Owner’s Representative shall witness all field testing.

END OF SECTION

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SECTION 40 05 65.17 - GLOBE HYDRAULIC CONTROL VALVES

PART 1 GENERAL

1.1 DESCRIPTION

A. The Pressure Relief / Surge Anticipator Globe Control Valve (V-700) shall control high pressures and power failure surges by bypassing system pressure that exceeds the high-pressure control setting and also by opening a preset amount when sensed pressure decreases below a preset minimum in anticipation of a surge.

B. The Globe Solenoid Control Valve (V-701) shall control shall control flow through the valve with a three way solenoid valve.

1.2 SUBMITTALS

A. The following information shall be provided:

1. Control Valve manufacturer's technical product data.

2. Control Valve manufacturer's Installation, Operation and Maintenance manual (IOM).

3. Provide specific information on all optional features specified above and confirm that these items are provided

PART 2 PRODUCTS

2.1 GENERAL

A. Main Valve:

1. The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern. The valve shall consist of three major components; the body with seat installed, the cover with bearing installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from line pressure. Packing glands, stuffing boxes and/or rolling diaphragm technology will not be permitted and there shall be no pistons operating the main valve or pilot controls. No fabrication or welding shall be used in the manufacturing process. Y-pattern valves shall not be permitted. Main valve shall comply with NSF/ANSI Standard 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component. Main Valve Body:

a. Material Specification Main Valve as follows:

b. Body & Cover Ductile Iron-ASTM A536

c. Main Valve Trim Stainless Steel

d. Disc Retainer Cast Iron

e. Diaphragm Washer Cast Iron

f. Seat Stainless Steel

g. Stem, Nut and Spring Stainless Steel

h. Seal Disc Buna-N® Rubber

i. Diaphragm Nylon Reinforced Buna-N® Rubber

j. Internal Trim Parts Stainless Steel:

k. Pressure Rating Class 150 lb. (250psi Max.)

l. Any other wetted metallic parts Stainless Steel

m. Coating Fusion Bonded Epoxy Coating (Interior and Exterior); ANSI / NSF 61 Approved / AWWA coating specifications C116-03.

2. No separate chamber(s) below the diaphragm shall be allowed between the main valve cover and body. No fabrication or welding shall be used in the manufacturing process.

3. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the discs firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hours-glass shaped disc retainers shall be permitted and no V-type or slotted-type disc guides shall be used.

4. The diaphragm assembly containing a non-magnetic stainless steel stem; of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the main valve cover and an integral bearing in the valve seat. The valve seat shall be a solid, one-piece design and shall have a minimum five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the

cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from the line pressure. No bolts or cap screws shall be permitted for use in the construction of the diaphragm assembly

5. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm's center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 X per layer of nylon fabric and shall be cycled tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

6. The main valve seat and stem bearing in the valve cover shall be removable. The cover bearing and seat in the 6" and smaller size valve shall be threaded into the cover and body. The valve seat in the 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc guide and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. The valve shall be designed such that both the cover assembly and internal diaphragm assembly can be disassembled and lifted vertically straight up from the top of a narrow opening/vault. Y-pattern valves shall not be permitted. The seat shall be of the solid one piece design. Two piece seats or seat inserts shall not be permitted. Packing glands and/or stuffing boxes shall not be permitted.

B. Pilot Control System:

1. Pressure Relief and Surge Anticipator Valve (V-700)

a. High Pressure Surge Relief Pilot: The pressure relief/sustaining pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. The pressure relief pilot control is normally held closed by the force of the compression in the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked. Pilot shall

comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

b. Low Pressure Pilot: The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to open when the sensed pressure falls below the control setting and close when pressures are normal. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall include a fixed orifice. The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

c. Flow Limiter: The pilot system shall contain an adjustable flow limiter to limit main valve travel during low pressure opening without affecting high pressure relief valve travel. This unique hydraulically operated flow limiter has two calibrated orifices, each positioned proportional to valve position, to vary main valve cover control chamber operating pressure. The hydraulically operated flow limiter regulates flow through main valve pilot systems based on valve position to prevent main valve exceeding predetermined flow. A manually adjustable orifice provides reference valve position. Valve position is linked to an integral sensor orifice. When valve position is below reference set-point of the hydraulically operated flow limiter, it allows unhindered pilot system flow. As valve position rises and approaches the reference control setting, the hydraulic flow limiter limits pilot system outward flow to build pressure in the main valve control chamber. Pressure continues to build until flow equals and hydraulically locks the valve at the flow limiters valve position set-point. Mechanical flow limiters shall not be permitted.

d. The pilot controls shall be hard piped, or bracket mounted to the main valve.

e. The pilot control system shall include a strainer, an adjustable closing speed and all required control accessories, equipment, control tubing and fittings. The pilot system shall include isolation ball valves on sizes as standard equipment. A full range of spring settings shall be available in ranges of 0 to 400 psi. Pilots to be manufactured by control valve manufacturer.

f. The Pressure Relief / Surge Anticipating Control Valve shall include a visual position indicator assembly on all sizes, as standard equipment.

2. Globe Solenoide Control Valve (V-701)

a. The solenoid shutoff pilot control shall be a direct acting three-way poppet solenoid valve, operating a high capacity three-way auxiliary diaphragm pilot

valve, controlled by an external electrical power source. Solenoid shall have a NEMA IV enclosure.

b. The pilot control system shall include a strainer, an adjustable closing speed and all required control accessories, equipment, control tubing and fittings. No variable orifices shall be permitted.

C. Ancillary Equipment

1. Each valve shall include an electric limit switch assembly to indicate that the valve is opening.

a. A stainless steel actuating stem with a swivel adapter fastened directly to the main valve stem moves through an adapter and gland with two O-Ring seals allowing the stop collar to actuate the micro switch bracket mounted on the exterior of the adapter which is attached to the cover of the main valve.

b. The single pole, double-throw micro switch can be connected either to open or to close the circuit when actuated. It is easily adjusted to operate at any point of the valve's travel simply by loosening the Allen screw and raising or lowering the collar on the actuating stem. The electrical switch shall be in weatherproof enclosure (NEMA rated).

D. Factory Assembly:

1. Each control valve shall be factory assembled.

2. The Quality Management System of the factory shall be certified in accordance with ISO 9001: 2008.

3. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories and control equipment.

4. During factory assembly the control valve manufacture shall make all necessary adjustments and correct any defects.

E. Nameplates:

1. Each Control Valve and associated pilot(s) shall be provided with an identifying nameplate.

2. Nameplates, depending on type and size of control valve, shall be mounted in the most practical position possible, typically on the inlet side of the valve body.

3. Nameplates shall be brass and a minimum of 3/32" thick, ¾" high and 2-3/4" long.

4. Pertinent control valve data shall be etched or stamped into the nameplate. Data shall include control valve Catalog number, function, size, material, pressure rating, end-connection details, type of pilot controls used and control adjustment range.

F. Factory Testing:

1. Each control valve shall be factory tested.

2. Tests shall conform to approved test procedures.

3. Shell Test: Control valves and pilot valves in the partially open position with both ends closed off with blind flanges (valves) and pipe plugs (pilots) shall be subject to a hydrostatic test. The applied pressure shall be 200 psi minimum. The pressure shall be applied for a minimum of 15 minutes. No visible leakage is permitted through the pressure boundary walls of the valve or pilot body or valve cover or the body-cover joint.

4. Seat Test: Control valves and pilot valves shall be subjected to an air pressure seat test and held for a minimum of 15 minutes. Pressure Rating -- Valve shall be suitable for a working water pressure of 250 psig.

G. Manufacturer

1. Cla-Val Co., Pressure Relief and Surge Anticipator Globe Valve (V-700) 52-03KC w/X105LCW.

2. Cla-Val Co., Globe Solenoide Control Valve (V-701) 136-03 w/X105LCW

PART 3 EXECUTION

3.1 GENERAL

Valve installation shall be in accordance with manufacturer's requirements.

3.2 SERVICES PROVIDED BY MANUFACTURER'S REPRESENTATIVES

The CONTRACTOR shall provide the services of the valve manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

SECTION 40 61 13 - PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies general requirements which are applicable to providing instrumentation and controls for the process system

B. The requirements of this section are applicable to all work to be completed by the System Integrator and as specified in all sections of 40 61 XX, 40 62 XX, 40 63 XX, 40 67 XX, 40 72 XX, 40 73 XX, 40 78 XX and 40 80 XX. Where XX refers to any specification section beginning with the preceding section numbers.

C. Electrical requirements applicable to this work are specified in Division 26.

D. Section includes:

1. Scope
2. Definitions
3. Quality Assurance.
4. Submittals.
5. Products.
6. Installation.
7. Testing.
8. Manufacturers Services.

1.2 SCOPE

A. The City's Control System Integrator, Simtek Industrial Controls and Automation, LLC, (541) 276-5500, shall provide all system integration for this project on this specification section as well as those listed or referenced herein. New primary process measurement devices, instrumentation and new process auxiliary devices.

1. New SCADA system hardware including digital process controllers (PLC based), IO modules, power modules, communication modules, network switches, UPS, and fiber optic patch panels.

2. New custom control panels, control stations, junction boxes, and control power distribution panels.

3. Process control system networking.

4. Modification of existing instrumentation and control for process systems.

5. Submittal documentation for process systems instrumentation and control including schedules, drawings, product manuals.

6. Maintaining construction RECORD/AS BUILT of submittal documentation and incorporating interconnection detail from other sections submittals to show accurately process systems instrumentation and control wiring as complete from circuits start and end connections.

7. Configuration set up, calibration, testing process systems instrumentation and controls.

8. Training.

9. Collaboration with System Programmer to provide a fully integrated PLC based SCADA system.

10. Assemble process control hardware into customized fabricated process control panel(s).

11. Factory test process control panel customized fabrication(s).

12. Deliver and install process control panel customized fabrication(s) on site.

B. PROGRAMMING: The System Programmer provides process control system PLC, SCADA and OIT application programming under a separate contract.

1.3 DEFINITIONS

A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.

B. VENDOR PACKAGE PROCESS CONTROL SYSTEM: A system of equipment and hardware provided by a vendor used for control, monitoring process conditions, control feedback and process performance for an associated vendor package equipment system which interfaces to the control system.

C. TWO-WIRE TRANSMITTER: An instrument which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit from a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms. A two-wire transmitter is also referred to as loop powered.

D. FOUR-WIRE TRANSMITTER: An instrument which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit

resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.

E. GALVANIC ISOLATION: Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

F. PANEL: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be pre- sent in the atmosphere.

G. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

H. SIGNAL TYPES:

1. LOW-LEVEL ANALOG: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.

2. HIGH-LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.

3. PULSE FREQUENCY: Counting pulses emitted from speed or flow transmitters.

4. DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits typically rated for 120 volts AC or 24 volts DC.

I. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, custom panel fabrication, instrumentation component purchase, instrumentation tuning, system and panel assembly, and testing the specified process control and industrial automation systems.

J. SYSTEMS PROGRAMMER: The Owner's hired programmer providing the PLC and SCADA application programming.

K. OIT: Acronym for Operator Interface Terminal

L. SCADA: Acronym for Supervisory Control and Data Acquisition

M. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project

1.4 QUALITY ASSURANCE

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

1.5 SYSTEMS INTEGRATOR

A. The City's Control Systems Integrator, Simtek Industrial Controls and Automation, LLC 541-276-5500 https://simtek-ica.com shall provide all system integration for this project.

1.6 SYSTEMS INTEGRATOR RESPONSIBILITY

A. GENERAL

1. The specified control system and instrumentation integration including new control panels, panel modifications, instrument supply and calibration, testing, startup, operational testing, and training shall be performed by the Systems Integrator.

2. The control system components shall, as far as practical, be of one manufacturer.

3. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

4. The specified system performance shall be demonstrated to and accepted by the Owner and the Engineer.

B. PRE-SUBMITTAL CONFERENCE:

1. Schedule a pre-submittal conference with the Owner and Engineer within 30-calendar days after Contract award to discuss the work equipment, submittal format, and establish the framework for project coordination and communication.

   a. Provide materials 10-days prior to the conference:

   b. Instrument Schedule specified in Section 40 06 70 with manufacturer and model number added.

   c. Product descriptive literature with a statement that the item is as specified.

   d. Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

   e. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

2. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

C. PROCESS EQUIPMENT COORDINATION

1. Systems Integrator shall provide wiring interconnect diagrams for the plant process control system to interface with submitted vendor equipment panels and devices. The wiring diagrams shall be a complete representation of the process control requirements for specific equipment. Systems Integrator coordinates to collect equipment wiring information from other Sections to show a totally wired integrated control system.

2. Integrate, furnish, and install equipment in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Systems Integrator shall obtain manufacturer’s technical information for items of equipment not provided with, but directly connected to, the control system.

Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.

5. Systems Integrator shall provide installation supervision for the duration of the project.

6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner for resolution before proceeding.

1.7 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Product Data: For each type of device and system:

1. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

    a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

    b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.

    c. Catalog cuts shall be assembled in a tabbed three ring binder. Each binder shall contain a cover sheet and index listing the sub- mitted items and cross-referenced to the appropriate specification paragraph. Where submittal information for equipment or materials covered by more than one specification Section is included within one binder, each tab shall be submitted as a separate submittal number. The tab shall be labeled with the submittal number.

    d. Where submittals are made electronically in PDF format, the PDF shall be organized by specification section and linked to an index. The PDF shall be searchable.

2. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

3. Manufacturer's installation instruction excerpts that apply to this project:

    a. Mounting requirements
    b. Electrical connection diagrams
    c. Calibration procedures
    d. Operation and maintenance information
    e. Warranty information

D. SUBMITTAL DRAWINGS

1. GENERAL

    a. Prepare drawings in AutoCAD version 2018 or later with borders and titleblocks identifying the project and system.

    b. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers.

    c. The drawing numbers and file names are to be based on equipment tag numbers.

    d. Provide the following submittal drawings

1) Arrangement and layout drawings

   a) Contract document's drawings are typical illustrations of panel hardware/component arrangement and layouts representing one or more than one panel with similar interconnection requirements. Provide the unique panel arrangement, layout and outline drawings. Show arrangement and layout to scale. Add components and wiring to the unique panel drawings as required to complete a fully integrated operation. Include on the drawings a Bill of Material that identifies all components in the arrangement and layout.

2) Schematic diagrams

   a) Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices and IO module layout connections. Show terminal blocks used for internal wiring or field wiring, identified as such.

3) Loop diagrams

   a) Provide the unique loop diagram for each piece of equipment.

4) Network block diagram

   a) A network block diagram is a diagram of the control system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols].

PART 2 PRODUCTS

2.1 GENERAL

A. MATERIALS AND QUALITY:

1. Provide process control hardware new, free from defects, and industrial- grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.

2. Electronic process control hardware shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

B. ENCLOSURES: NEMA rating for the location and application shown herein and as specified in Section 40 67 16, Division 26, and as shown on the drawings.

Location	Enclosure Material and NEMA Rating
Indoor Dry	NEMA 12: mild steel
Indoor Wet	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Chemical Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.2 NAMEPLATES

A. Provide nameplates for all field mounted instrument, analyzer, or equipment. Include the equipment title, the equipment tag number, and power source(s) in the nameplate inscription. Provide machine engraved laminated black phenolic nameplates with white lettering for equipment identification with 1/8-inch high lettering.

2.3 ISOLATION AND SURGE PROTECTION

A. Surge protect power and output signals for transmitters located outdoors:

1. Signal: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or approved equal.

2. AC Power: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector. External surge protector UL 1449, LED indicator, screw terminal connections, NEMA 4X, EDCO HSP121A or approved equal.

3. Provide a terminal junction box for housing external surge protector. Box to match NEMA rating of the transmitter.

B. Provide intrinsic safety barrier with two-wire transmitter located in a facility area classified as hazardous per the NEC when instrument is not available as explosion proof (Class I, Division 1) or an alternative protection method recognized by NEC (Class I,

Division 2). Require the two-wire transmitter product manufacturer to list intrinsic safety barriers as an acceptable method for installation in a hazardous classified area.

1. Intrinsic safety barriers for two-wire transmitters to be of the active, isolating, loop powered type. Barrier shall be as recommended by the two-wire transmitter product manufacturer, or accepted equal.

2.4 TRANSMITTER

A. Comply with the following for primary process measurement transmitters unless specified elsewhere for specific instruments:

1. Operating power derived from the signal transmission circuit for two-wire type transmitters.

2. Provide load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% corresponding to 4 to 20 mA dc for the transmitter.

3. Configure transmitter output to increase with increasing measurement unless otherwise noted.

4. Input and output signals 4 to 20 milliamperes with error not exceeding 0.1 percent of span. Input resistance not to exceed 550 ohms with an output load of 250 ohms.

5. Provide transmitter enclosures as rated NEMA 250, Type 4X, unless otherwise specified.

2.5 SPARES:

A. Provide 10% spare for most components or at least one spare for each panel component unless a larger specific requirement is listed herein.

1. Power Supplies – 1 of each type used
2. Terminal Blocks – 5 of each type used
3. Fuse – 5 of each type used
4. Circuit Breakers – 2 of each type and size used
5. Surge Protection Devices – 1 of each type used
6. Relays – 2 of each type used
7. Relays Bases – 1 of each type used
8. PLC Modules – 1 of each type used

PART 3 EXECUTION

3.1 INSTALLATION

A. GENERAL:

1. Install process control hardware in locations that are accessible for operation and maintenance services. Process control hardware not accessible shall be reinstalled at no cost to the Owner.

2. Install process control hardware in accordance with product manufacturer's requirements.

3. Ensure process control hardware is grounded per NEC and manufacturer's requirements.

4. Provide proper clearance for process control hardware for heat dissipation and access.

5. Ensure UL/FM or equal listings/markings/labels are viewable after installation.

6. Provide secure mounting of all process control hardware (such as DIN rail mount).

7. Provide electrical circuit protection for process control hardware if not integral.

B. FIELD EQUIPMENT:

1. Provide equipment with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 50 inches and 60 inches above the floor or permanent work platform. Mount equipment to avoid shock or vibration that may impair operation. Mount equipment for unobstructed access and walkways. Equipment support systems not to be attached to handrails, process piping or mechanical equipment.

2. Space instruments and cabinets supported by concrete walls by 5/8 inch using framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized after fabrication or shall be 316L stainless steel, as shown or specified.

3. Design support systems for panels to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

4. In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry

from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.

5. Provide nameplates for all primary process measurement devices. Attach nameplates to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.

6. The transmitter's output indicator or the switch's status lights must be viewable from floor or permanent work platform without obstruction.

7. Provide configuration equipment including cables and software to communicate with and configure instruments.

C. ELECTRICAL POWER CONNECTIONS:

1. Equipment electric power wiring shall comply with Division 26. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location (including circuit breaker number). "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.

2. Equipment power disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location requirements cannot be met by a single disconnect switch, provide two disconnect switches: one at the equipment and one at the work platform.

3. Provide a surge arrestor on each 120-volt AC disconnect switch serving primary process measurement device located outdoors.

D. CONTROL AND SIGNAL CONNECTIONS:

1. Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.

2. Jacketed flexible conduit shall be used between equipment and rigid raceway systems (Section 26 05 33). Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 3 feet except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.2 TESTING

A. DELIVERY INSPECTION: Notify the Owner upon arrival of any material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner may inspect such items.

B. REQUIREMENTS: Section 40 61 21.

3.3 MANUFACTURER'S SERVICES

A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.

B. Procedures specified in section 01 75 16.

C. Provide the services for a minimum of 2 hours per instrument to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

D. Training sessions to be of adequate duration to cover the scope of the project. Do not repeat a device training if covered in multiple process areas; provide reference to the training session where the device was covered.

E. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.

F. Training to include configuration, operation, troubleshooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control instrument type.

G. Certify completion of training.

END OF SECTION

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SECTION 40 61 21 - PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Quality Assurance
3. Submittals
4. Product
5. Execution – General
6. Preoperational Test Phase
7. Component Test Phase
8. Operation Test Phase

1.2 SCOPE

A. This section specifies Contractor and Systems Integrator requirements for testing and documenting the process instrumentation and control system (PICS) for automation integration with SCADA in conjunction with the City's Systems Programmer.

B. The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

C. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all test procedures with the requirements of Section 01 75 16 Startup Procedures.

1. Include the following action items

a. Develop test plan.

b. Develop record keeping system.

c. Coordinate testing with Vendor package equipment.

d. Coordinate testing with the Owner's Systems Programmer.

D. Testing to include:

1. Pre-Operational - Factory Acceptance Testing (FAT)

2. Component Testing Sequence:

a. Wiring Testing

b. Network and Bus Cable System Inspection and Testing

c. Piping Testing

d. Installation Inspection

e. Instrumentation Calibration

f. Loop Testing

g. Network & Telemetry Testing

3. System (Functional) Testing Sequence:

a. Process Control Strategy/Sequence Testing

b. Control System Closed Loop

c. Functional Checkout

4. Operational Testing:

a. System Acceptance Testing (SAT)

E. Definitions: Section 40 61 13 for definition of System Integrator and Owner's Programmer.

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. TESTING MANAGER:

1. The Contractor or Systems Integrator shall appoint a qualified specialist as process control system testing manager to manage, coordinate, and supervise the testing work.

2. The Testing Manager requires at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of electrical and instrumentation control systems of equal or greater scope and complexity. Testing Manager to provide a quality assurance program which includes:

a. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the P&ID drawings.

b. Sequential list of the test phases required for each process area and system.

c. Completion status tracking form by process area, system, and test phase.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00 Submittal Procedures

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Package 1:

Organize the submittal items in the following manner for review.

1. QUALIFICATION SUBMITTAL

a. Testing Manager Qualifications and resume

b. Network testing entity qualifications and staff performing inspections and testing

D. Package 2:

1. DEFINITION SUBMITTAL

a. Control descriptions in accordance with the requirements of paragraph 40 61 21 - 2.2 C.

b. I/O Interface Summary in accordance with the requirements of paragraph 40 61 21 - 2.2 D.

c. Testing status spreadsheet in accordance with the requirements of paragraph 40 61 21 - 2.2 A. 3.

d. Test procedures in accordance with the requirements of paragraph 40 61 21-3.1 D.

e. Proposed test forms per PART 3 of this Section 40 61 21, detailed for each test for this project.

f. Certified Factory Calibration Reports.

g. Provide up to date, as constructed control system drawings in accordance with 40 61 13 - 1.7.

h. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

E. Package 3:

1. FAT SCHEDULE AND LOCATION

F. Package 4:

1. Completed Test Forms:

a. Completed test forms per PART 3. Separate submittals may be provided for each process area.

b. List of factory calibrated items and calibration certificates.

c. Documentation of network data communication nodes for networked controllers, remote I/O and related devices.

d. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities for a facility.

1) Label the binder cover and spine to identify the project name and facility. Test report includes the applicable test procedures for the facility and the completed inspection and test report forms associated with the equipment and systems of that area.

2) Organize test results by equipment item or system with individual, labeled tab dividers to identify each. System deficiencies and non-compliant test results identified in the final test report and acknowledged by the responsible party as having been corrected.

PART 2 PRODUCTS

2.1 GENERAL

A. The Testing Manager shall provide test forms, documentation, and records as specified in the following paragraphs.

2.2 TESTING DOCUMENTATION

A. DOCUMENTATION RECORDS: The Testing Manager shall develop a record keeping system to document progress and completion for each task in each process area or system. Keep the following current and available for inspection on-site at all times in a location designated by the Owner:

1. Testing Manager's qualifications, project startup and testing history, including resume as specified in this Section.

2. List of names of Contractor’s and System Integrator’s personnel associated with final construction and testing, and normal and emergency contact telephone numbers.

3. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.

4. Test Report Volumes.

B. TEST REPORT VOLUMES: The Contractor develops and maintains testing documentation for each area of the facility in separate volumes. Keep each volume current and available for inspection on-site at all times in a location designated by the Owner. Each volume includes the following as a minimum:

1. Three-ring binder with front cover and spine labeled: “Testing Documentation For Process Area / Process System” including Owner’s name, facility name, project name, and project number.

2. Table of Contents with same labeling as the volume cover with tabs for each section:

    a. Section 1 – Control Description

    b. Section 2 – I/O Interface Summary

    c. Section 3 – Schedules for Integrated Automation Instrumentation and Terminal Devices

    d. Section 4 – Test Forms

    e. Section 5 – Certified Factory Calibration Reports

    f. Section 6 – Final Test Report

C. I/O INTERFACE SUMMARY: Provide I/O spreadsheets for each area of the facility based on the contract drawings, and IO lists. Spreadsheets to include the following for each I/O point:

1. Signal number/tag
2. Annotation description that may be logically abbreviated and that is subject to approval.
3. Complete physical I/O channel designation and addressing or communication I/O register designation.
4. True/False status designations for digital I/O.
5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.
6. Signals: Fixed point and scaled at the Controller with minimum four significant implied digits of scaling. E.g.: 0 to 1400 at Controller for a pH range of 0 to 14 at Operator Interface.
7. Provide Operator Interface scaling to display decimal digits required.
8. Test result- pass or fail and date of test.
9. Maintain in Excel with electronic updates to Owner issued within 2 days after each test after any updates or changes by Contractor.

PART 3 EXECUTION

3.1 GENERAL

A. GENERAL REQUIREMENTS:

1. Prior to testing, provide notice to the Owner. Provide notice between 60 and 70 days before starting any testing activity, and include a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.

2. System integrator to provide detail assistance to the Contractor in generating test forms, customized for this project.

B. TECHNICIAN QUALIFICATIONS:

1. Calibrate and set up field instruments and analyzers using a certified instrument technician qualified to calibrate the instrumentation.

2. Technicians are to be qualified by completion and certification from training courses offered by the Instrumentation, Systems, and Automation Society (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

C. TEST EQUIPMENT AND MATERIALS:

1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.

2. Ensure test instruments have a current calibration sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.

3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically documents instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.

4. Provide an instrument calibration system such as Fluke 743B with Fluke DPC/Track Instrumentation Management software or similar system. Submit calibration files

with the final test report in hard copy and electronic formats that do not require specialized equipment or software to read and print the files.

5. Provide buffer solutions and reference fluids for tests of analytical equipment.

6. Vendor software tools may document the systems where a licensed copy of the identical software including connectors, cables, keys, interface cards and devices required for operation is submitted with the final documentation files.

D. FIELD TEST PROCEDURE DOCUMENTATION:

1. Organize and assemble in separate volumes for each process area test procedures for each analog and discrete loop in the process control system. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.

2. Include test procedure documentation with detailed step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.

3. Include test report forms for each loop covering wiring, piping, and individual component tests. Record the actual test results on these forms and assemble a final test report as specified in this Section.

4. Preprint and complete test report forms to the extent possible prior to commencing testing. Include for test report forms that document the field test procedures the following information:

   a. Project name

   b. Process area associated with the equipment under test.

   c. Instrument loop description.

   d. Instrument loop identification number.

   e. Instrument nameplate data.

   f. Instrument setup and configuration parameters.

   g. Time and date of test.

   h. Inspection checklist and results.

   i. Reference to applicable test procedure.

   j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.

   k. Test equipment used.

l. Space for remarks regarding test procedure or results, unusual or noteworthy observations, etc.

m. Name, date, and signature of testing personnel.

n. Test witness' name and signature.

E. INSTALLED TESTS

1. Provide test forms in conformance with the referenced forms. Develop additional or detailed forms as necessary to suit complex instrumentation. Usage of terms used on test forms shall comply with ISA S51.1.

F. WITNESSING

1. The Owner reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify Owner and Owner's System Programmer prior to testing, as specified herein.

3.2 PREOPERATIONAL TEST PHASE

A. FACTORY ACCEPTANCE TEST (FAT):

1. GENERAL: Factory Acceptance Test control system equipment witnessed by the Owner. The Owner's System Programmer loads control system panel programmable logic controllers (PLCs) with testing software to allow the PLCs to view the process control hardware integrated in specified panels at the System Integrator factory prior to the FAT. System Integrator sets up a temporary network with power to the equipment and collaborates the testing with the Owner's System Programmer to be able to check out the process control hardware. Provide written notice to the Owner and the Owner's System Programmer thirty working days before the commencement of the FAT activity which includes:

a. Schedule for the FAT.

b. Location of the FAT.

c. Testing equipment used.

d. Detailed test procedure with forms for the recording of test results.

e. Sign-off spaces for the individuals performing and witnessing the tests.

2. FACTORY ACCEPTANCE TEST PROCEDURES: Interlock or network panels as applicable, operated, and checked-out by the equipment supplier prior to the FAT. Submit certification indicating that the panels are ready for the FAT. Include in the FAT the following:

a. Visual inspection of equipment, instruments, control panels, and graphic displays.

b. Validate each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs with the Owner's System Programmer.

c. Validate with the Owner's System Programmer the following:

1) Monitoring state changes on operator interface screens based on the inputs state change.

2) Observation of online PLC programming application software with the associated PLC outputs state change.

3) Outputs triggered by operator interface software devices (pushbuttons, sliders, manually-entered values, etc.)

4) Calibration and operation of instruments on or in the control panels.

d. Repair of loops which do not pass validation.

e. Retest of the FAT at no additional cost.

f. Panels that pass the FAT may be shipped to the site upon shipping schedule and storage accommodation approval by the Owner.

3.3 COMPONENT TEST PHASE

A. GENERAL REQUIREMENTS: In general, perform tests in the following order

1. WIRING TESTING: Provide electrical power and signal cable ring-out and resistance testing. Conduct test in accordance with Sections 26 05 00 and 26 08 00. Do not conduct wiring tests until cables have been tagged and inspected.

a. Power and Control: In accordance with the requirements of Section 26 08 00.

b. Test shield to ground in panels and cabinets to verify terminal connections.

c. Sample test forms are included at the end of this section.

2. NETWORK AND BUS CABLE INSPECTION AND TESTING

a. Inspect and test by independent industrial network testing firms.

b. Test proprietary bus systems by the manufacturers' qualified field services technician. Manufacturer's sales personnel are not considered to be qualified

technicians unless qualifications are documented and certified by the manufacturer.

c. Test standardized networks and buses by a qualified independent network testing service. Test the following types of cabling and networks, and certify by the independent industrial network testing firm:

    1) Ethernet system cabling

    2) Other networks provided as a part of a vendor packaged monitoring or interfacing to the process control system.

d. Test and verify control and instrumentation bus cabling using the standards that apply to the specific cable and bus type as follows:

    1) Ethernet Category 5E and Category 6: in accordance with the requirements of TIA/EIA-568B standards

    2) PRE-ACTIVE TESTING: Prior to energizing, inspect and test cabling to verify the following:

        a) Media type and specifications.

        b) Physical routing and project specific cable identification tagging.

        c) Correct termination installation and connection of conductors to pins at terminations.

        d) Record cable run length and compare to the manufacturer or industry standards to verify lengths are within specifications.

        e) Locations and values of network termination resistance.

        f) Integrity and grounding of cable shields.

        g) Values of transient protection (surge) elements.

        h) Firmware revision level of network devices available prior to energization.

        i) Settings of dip switches and configuration parameters.

    3) ACTIVE SYSTEM TESTING: After the cable or network system has been activated for testing, provide diagnostic monitoring and signal analysis for the bus network system to evaluate network and bus integrity and data transfer quality. Measure, verify and record the following parameters:

a) Node addressing.

b) Signal attenuation before and after any repeater device and at the farthest point in the network.

c) Total network trunk voltage and current loading as applicable.

d) Baud rate, message traffic rate, percent bandwidth used, error rate, lost packet count.

e) Firmware revision level of the network devices.

f) Pre-active and active testing shall fall within the specified range of values established by the referenced standards.

g) Correct the functionality of networks and devices connected to the network.

3. INSTRUMENT AND COMPONENT INSPECTION: Inspect PICS components include the following:

   a. Compare and validate instrument type and nameplate data with the drawings, specifications, and data sheet.

   b. Validate instrument identification tag.

   c. Confirm instrument installation conforms to drawings, specifications, and manufacturer's instructions.

   d. Verify proper conductor termination and tagging.

   e. Visual check for physical damage, dirt accumulation, and corrosion.

   f. Verify all components and instruments including isolation amplifiers, surge protection, and safety barriers are properly installed.

   g. Report deficiencies identified within 24 hours of discovery. No instrument or system component shall be tested until all deficiencies are addressed.

4. INSTRUMENTATION CALIBRATION:

   a. Field calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and test in accordance with the Contractor's submitted test procedure.

b. Do not commence individual component calibration and testing until Instruments and Component Inspections are completed and documented to the satisfaction of the Owner and the Engineer.

c. Calibrate analog instruments at 0, 10, 50, 90, and 100 percent of the specified full-scale range in both ascending and descending order. Adjust each signal sensing trip and process sensing switch to the required setting. Record calibration data on test forms as specified herein.

d. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.

e. Enter test data on the applicable test forms at the time of testing: Set alarm trips, control trips, and switch dead bands to initial values specified in the control narratives in section 40 61 96. Check final elements for range, dead-band, and speed of response.

f. Repair or replace by the manufacturer any component that fails to meet the required tolerances. Repeat the specified tests until the component is within tolerance.

g. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.

h. Use test form at the end of this section

5. CERTIFIED TEST REPORTS: Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at five operating points within the instrument range. Return for re-calibration or replace as agreed depending on the impact to the project as determined by the Owner and Engineer, any instrument which fails to demonstrate proper performance.

6. LOOP TESTING: System Integrator to collaborate the loop testing with the Owner's System Programmer. The System Integrator is to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly and recording testing results. The Owner's System Programmer verifies the application programming.

   a. Do not commence Loop Testing until the Individual Component Calibration and Testing has been completed and documented to the satisfaction of the Owner and Engineer.

b. Test each instrument loop as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Inject test signals at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

c. Testing of loops with an interface to a programmable logic controller and SCADA graphical user interface are to include verification of the programmable logic controller input/output assignment and verification of operation of the input/output system, processor and SCADA. Test loop from field through programmable logic controller and SCADA with the Owner's System Programmer.

d. Correct the loop circuitry or device if the output control or monitoring device fails to indicate properly. Repeat the test until devices and instruments operate as required.

e. See test form at the end of this section.

3.4 SYSTEM TEST PHASE

A. GENERAL: System Integrator to collaborate the system test phase with the Owner's System Programmer. The System Integrator to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly, tuned as required, and recording testing results. The Owner's System Programmer verifies the application programming.

B. PROCESS CONTROL STRATEGY/FUNCTIONAL TESTING:

1. Do not commence Control Strategy Testing until the Loop Testing has been completed and documented to the satisfaction of the Owner and Engineer.

2. Control Strategy Testing consists of installing and debugging the PLC control logic program, verifying the interface points between the PLCs and field devices and equipment, and exercising the control strategies. Perform Control Strategy Testing on one PLC at a time.

3. Provide qualified personnel to immediately correct any deficiencies in the Work that may be encountered during Control Strategy Testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete Control Strategy Testing.

C. CONTROL SYSTEM CLOSED LOOP TESTING:

1. Do not commence Closed-Loop tests until the Control Strategy Testing has been successfully completed and documented to the satisfaction of the Owner and Engineer.

2. Demonstrate closed-loop tests, performed as part of the system tests, provide stable operation of each loop under operating conditions. Adjust loop tuning parameters as required during the testing.

3. Tuning parameters for PID control: Tune the gain (or proportional band), integral time constant, and derivative time constant for each control loop. Adjust to provide 1/4-amplitude damping, unless otherwise specified.

4. Adjust control loops with "batch" features to provide optimum response following start-up from an integral action saturation condition.

5. Provide graph recordings to show the PID response (include set point, control output, measured feedback) at initial start-up, during sequencing, during a step disturbance additional and show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.

6. Where a loop is controlled under the direction of a programmable logic controller, the Owner's System Programmer will perform the necessary adjustment of loop tuning parameters and set points; Contractor records the loop response, adjusts final elements, and assures total integrated loop performance as specified.

D. FUNCTIONAL CHECKOUT:

1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 75 16 Startup Procedures.

2. Exercise the operable devices and energizing the control circuit.

3. Operate control element, alarm device, and interlocks to verify the specified action occurs.

3.5 OPERATIONAL TEST PHASE

A. Perform System Acceptance Test (SAT) after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that all functional requirements of this specification have been met. System Integrator to collaborate SAT with the Owner's System Programmer. The System Integrator to be in the field with the Owner's System Programmer to assist in the testing by verifying wiring and equipment is functioning properly, tuned as required, and recording testing results. The Owner's System Programmer verifies the application programming. Demonstrate during SAT the following:

1. Each component of the system operates correctly with all other components of the system.

2. Analog control loops operate in a stable manner.

SAMPLE INSTRUMENT CALIBRATION SHEET

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model: Serial #:	Name:

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N Action? direct / reverse Modes? P / I / D
Indicate? Y / N	Chart:			Describe:	
Record? Y / N	Scale:				SWITCH? Y / N Unit Range: Differential: fixed/adjustable Reset? automatic / manual
Transmit/ Convert? Y / N	Input:				
	Output:				

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
							1.					
							2.					
							3.					
							4.					
							5.					
							6.					
CONTROL MODE SETTINGS:			P:	I:	D:		7.					

#	NOTES:	Component Calibrated and Ready for Startup
		CONTRACTOR'S REPRESENTATIVE:
		Date:
		Tag No.:

SAMPLE MOTOR DATA FORM:

Equipment Name____Equipment No(s) ____

Project Site Location _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	ºC
Time rating:				Design Letter:			
	(NEMA MG1-10.35)				(NEMA MG-1.16)		
KVA Code Letter:				Insulation Class:			

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class___, Div___, Group _____

B. UL frame temperature code_____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency __

B. Nameplate or nominal efficiency __

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:	ºC (NEMA MG1-12.41,42)				
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if					

Provide information on other motor features specified:

SAMPLE TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.:_____Serial No.: _____

Input: _____

Output: _____

Range:_____Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED_____Date _____
Contractor's Representative

WITNESSED_____Date _____
Owner's Representative

SAMPLE CONTROL LOOP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.:_____ Serial No.: _____

Input:_____ Process Variable (PV) Scale: _____

Output:_____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Readin	Expected	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation			% Deviation			% Deviation		

CERTIFIED_____ Date _____

Contractor's Representative

WITNESSED_____ Date _____

Owner's Representative

END OF SECTION

SECTION 40 61 26 - PROCESS CONTROL SYSTEM TRAINING

PART 1 GENERAL

1.1 SUMMARY

A. CONTRACTOR shall provide operator training on the operation and maintenance of the control system and all components.

B. The process instrumentation and control Work for which training is to be provided includes, but is not limited to, the following:

1. Field-mounted instruments and devices.

2. Programmable logic controllers (PLC)

3. Personal computers and human-machine interface (HMI) software.

4. Local area network hardware and software.

5. Field instruments network communication hardware and software required for interfacing various systems to provide a fully-integrated system.

C. Coordination

1. Some panels and equipment are furnished under other Specification Sections. Under this Contract the PCS contractor shall coordinate the training for the use and maintenance of equipment they provide with control equipment provided with packaged equipment and with the PLC and SCADA system programming that will be provided by the OWNER's Programmer. CONTRACTOR shall coordinate with Suppliers of panels and equipment to provide fully functional system complying with the Contract Documents and that interfaces with the process control network.

1.2 SCOPE

A. Process Instrumentation and Control System Work for which training is to be provided is specified in Division 40 as a whole. This includes but is not limited to the following Specification sections:

1. 40 63 43 Programmable Logic Controllers

2. 40 62 63 Operator Interface Terminals (OIT)

3. 40 71 36 Turbine Flow Meters

4. 40 71 66 Transit Time Flow Meters

1.3 REFERENCES

A. Underwriters Laboratory (UL).

B. National Electrical Manufacturers Association (NEMA).

C. Instrument Society of America (ISA).

D. ISA 5.4, Instrument Loop Diagrams.

E. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.

F. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.

G. NFPA 79, Electrical Standard for Industrial Machinery.

1.4 SUBMITTALS

A. Operator Training plan and schedule

B. Maintenance Training and schedule

1.5 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.

2. Perform training to meet specific needs of Owner's personnel.

3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.

5. Owner reserves the right to reuse videotapes of training sessions.

B. Management Seminar:

1. Length: 2 days.

2. Location: Owner's facility.

3. Objective: Provide overview for non-operations and non-maintenance personnel for understanding the Process Control System.

4. Attended by management, engineering, and other non-operations and non-maintenance personnel.

5. Primary Topics:

    a. Control System Overview: How hardware and software are used for operation and control of facilities.

    b. Block Diagram Presentation of control system: How and what information flows within system and what is done by each functional unit.

    c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.

    d. Management-oriented explanation of data management displays and printouts.

    e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:

    a. Refer to specific requirements specified in Div 40 Subsections.

    b. Include review of O&M data and survey of spares, expendables, and test equipment.

    c. Use equipment similar to that provided.

    d. Unless otherwise specified in Process Control System subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

2. Operations Training: For Owner's operations personnel on operation of I&C components.

    a. Training Session Duration: 1/2 instructor days.

    b. Number of Training Sessions: Two.

    c. Location: Project Site.

    d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.

e. Content: Conduct training on loop-by-loop basis.

1) Loop Functions: Understanding of loop functions, including interlocks for each loop.

2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.

3) Interfaces with Process Control System subsystems.

3. Maintenance Training:

a. Training Session Duration: 1/2 instructor days.

b. Number of Training Sessions: Two.

c. Location: Project Site

d. Course Objective: Develop skills needed for routine maintenance of Process Control System.

e. Content: Provide training for each type of component and function provided.

1) Loop Functions: Understanding details of each loop and how they function.

2) Component calibration.

3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.

4) Troubleshooting and diagnosis for equipment and software.

5) Replacing lamps, fuses, etc.

6) I&C components removal and replacement.

7) Periodic preventive maintenance.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 CLASSROOM TRAINING

A. Provide a minimum of 4 hours of classroom training on process control system components for each training session. Conduct one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff. Certify completion of training.

B. Training session will present and review the procedures and information that will be used in the field training sessions in addition to information required for obtaining service and replacement parts.

3.2 FIELD TRAINING

A. Training sessions to be 1-hour duration and do not repeat a device training if covered in multiple Facility areas; provide reference to the training session where the device was covered. Conduct one training session for each device type per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.

B. Training to include a demonstration of configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each device type.

3.3 MANUFACTURER'S SERVICES

A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.

B. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.

C. Training to include configuration, operation, troubleshooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control hardware type.

D. Certify completion of training on form provided herein.

END OF SECTION

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SECTION 40 62 63 - OPERATOR INTERFACE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Product Requirements
6. Installation
7. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and installation of an Operator Interface Terminal. The Operator interface panel shall be Allen Bradley “PanelView Plus 7” series with touchscreen, Model 2711P-T7C21D8S.

B. Provide and test OIT with programmable logic controller and other process control hardware specified to form a functional process control system (PCS).

C. Provide OIT with screen size as specified on the drawings with sufficient RAM memory to support the visualization programming requirements of the application including screen navigation, alarming, datalogging, etc.

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. NEMA – National Electrical Manufacturer’s Association
C. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 67 00 Control System Equipment Panels and Racks and 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00 and 40 61 13.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 61 13.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Candidate manufacturers and models include the following

1. Rockwell Automation\Allen Bradley

2. No substitutions allowed

2.2 ENVIRONMENTAL REQUIREMENTS

A. Operating Temperature of 32 to 131 degrees F.

B. Vibration tolerance of 57 to 500 hertz at 2 G peak acceleration

C. Shock withstand during operation of 15 G at 11 milliseconds

D. NEMA/UL Type 12, 13, 4X (indoor use) and IEC IP66

2.3 FEATURES

A. Thin Film Transistor (TFT) Color graphic display

1. Four-wire analog resistive, single touch

2. 18-bit color graphics

3. Brightness: 300 nits minimum

B. Battery or capacitor backed real time clock (30-day minimum)

C. SD card memory slot

D. 512 MB RAM

E. Windows CE 6.0 or newer operating system.

F. Battery backed real time clock

G. Analog resistive Touch screen

2.4 ELECTRICAL REQUIREMENTS

A. C-UL-us Listed for Class I, Div. 2 Groups A, B, C &D; Class II, Div. 2, Groups F, & G.

B. Supply Voltage 120 VAC, single phase or 18 – 32 VDC as shown on the drawings

2.5 COMMUNICATION REQUIREMENTS

A. Communication protocol compatible with the PLC as listed on the drawings.

B. Ethernet TCP/IP 100 MB and/or serial port as listed on the drawings.

C. Optional 2-port Ethernet embedded switch

D. Two USB for peripherals

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and Install in accordance with manufacturer's instructions for the specified functional requirements.

B. Install Operator Interface panel per manufacturer’s instructions.

C. OITs shall be installed at 5’2” to center of screen for finished floor or walkway directly in front of the install location. In the event mounting height is unclear due to other information or situations, Contractor shall submit an RFI to verify desired mounting height before proceeding with installation.

D. The screens for the operator interface terminal shall be consistent with the layout of the existing operator interface screens within the system. Consult with Owner to provide access to those stations for preview whom may provide a copy of the current programming of one of the stations upon request.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation per manufacturers recommendations

3.3 MANUFACTURER’S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

END OF SECTION

SECTION 40 63 43 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

A. Programmable logic process controllers are also known as programmable logic controllers (PLCs) and central processing unit (CPU). This section specifies general requirements for programmable logic process controllers and I/O Modules

B. Section includes:

1. Scope
2. Quality Assurance
3. Submittals
4. Performance Requirements
5. Products
6. Installation
7. Testing
8. Manufacturer's Services

1.2 SCOPE

A. Provide and test programmable logic process controllers with other process control hardware specified to form a functional process control system (PCS) integrated into the existing City-wide supervisory control and data acquisition (SCADA) system.

B. Provide programmable logic process controllers sized for the input/output requirements as specified on the drawings. Provide programmable logic process controllers sized for executing the control sequences for the PLC and SCADA logic.

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00 and 40 61 13

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURERS

A. PLC shall be Allen-Bradley (Rockwell Automation) CompactLogix 5380 and required I/O shall be 1769 series controlled with remote Ethernet adapter 1769-AENTR.

2.2 MATERIALS

A. Provide new, free from defects, and industrial-grade PLC, Communication module and I/O as specified within this Section.

1. PROCESSOR – Allen-Bradley 5068-L306ER

2. COMMUNICATION MODULE- Allen-Bradley 1769-AENTR

3. POWER SUPPLY - Allen-Bradley 1769-PB2 or 1769-PB4

4. DISCRETE INPUT - Allen-Bradley 1769-IQ16

5. DISCRETE OUTPUT- Allen-Bradley 1769-OW8I

6. ANALOG INPUT- Allen-Bradley 1769-IF4

7. ANALOG OUTPUT- Allen-Bradley 1769-OF4

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation requirements: PLC and I/O to be din rail mounted inside control cabinets as specified in Section 40 67 16 and 40 67 19 and as shown on the drawings

3.2 TESTING

A. Testing requirements specified in: Section 40 61 21.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

END OF SECTION

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SECTION 40 63 43.13 - PLC INPUT/OUTPUT MODULES

PART 1 GENERAL

1.1 SUMMARY

A. OVERVIEW: This section specifies general requirements for process control input/output (I/O) modules used with:

1. Programmable Logic Process Controllers specified in Section 40 63 43.

B. Section includes:

1. Scope
2. Quality Assurance
3. Submittals
4. Performance Requirements
5. Products
6. Installation
7. Testing
8. Manufacturer's Services

1.2 SCOPE

A. Provide IO modules as specified on the drawings.

1.3 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.4 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00 and 40 61 13.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information

contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Rockwell Automation, (Allen-Bradley PLC), CompactLogix Series local input/output modules unless otherwise specified.

2.2 MATERIALS

A. Provide new, free from defects, and industrial-grade input/output modules as specified within this Section.

2.3 INPUT/OUTPUT MODULES

A. Local input/output modules:

Equipment	Manufacturer/Model
Expansion I/O power supply, 24vdc, integral	Allen-Bradley 1769-PB2 or 1769-PB4
Analog input module, 4–20 mA, 4 inputs	Allen-Bradley 1769-IF4
Analog output module, 4–20 mA, , 8 outputs	Allen-Bradley 1769-OF4
Discrete input module, 24 VDC, 16 inputs	Allen-Bradley 1769-IQ16
Discrete output module, 8 outputs, Relay	Allen-Bradley 1769-OW8I

B. Application requirements are specified in the Input/Output Lists of the sub-sections of 40 xx xx and/or on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation requirements: Local input and output modules are din rail mounted as specified in Section 40 67 16 and 40 67 19 and as shown on the drawings 3.2

3.1 TESTING

A. Testing requirements specified in: Section 40 61 21.

3.2 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

END OF SECTION

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SECTION 40 67 16 - CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Panel Information
3. Panel Design
4. Quality Assurance
5. Submittals
6. Performance Requirements
7. Products
8. General

1.2 SCOPE

A. This section specifies requirements for process control panels and hardware required for custom fabrication.

B. Provide the instrument, control, and monitoring features indicated on the electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label.

C. Panels that contain programmable logic controllers (PLC) are as shown on the drawings.

D. Comply with the specified products in Sections 40 61 13. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier’s facility for corrections, testing, relabeling and inspection.

E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.

F. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor controllers,

combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

G. Submittal drawing requirements specified in Section 01 33 00 and 40 61 13.

H. Label panels with fault current rating per NEC article 409.110.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. American National Standards Institute (ANSI).

2. ASTM International (ASTM):

a. B75, Standard Specification for Seamless Copper Tube.

3. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. ICS 4, Industrial Control and Systems: Terminal Blocks.

4. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

5. Underwriters Laboratories, Inc. (UL):

a. 508A, Standard for Safety Industrial Control Panels.

b. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

c. 698A, Industrial Control Panels Relating to Hazardous (Classified) Locations.

1.4 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

D. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

E. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.

2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad) and is used for the transmission of low current or low voltage signals.

F. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

G. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices. Synonymous with Programmable Automation Controller (PAC) for purposes of this project

H. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

I. Input/Output (I/O): Hardware for the transmission of control signals into and/or out of a PLC or RTU.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

K. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

L. Uninterruptible Power Supply (UPS):

1. A backup power unit that provides continuous power when the normal power supply is interrupted.

2. Sized to provide a minimum of 1 hour of continuous operation of all connected components.

M. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.5 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty specified equipment herein for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

C. Entire assembly shall be affixed with a UL 508A or 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

D. Each panel shall have an affixed fuse identification list.

E. Each panel shall have an affixed power and short circuit rating label.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements,

with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Submittal items required include:

1. Submit items specified in Section 40 61 13
2. Arrangement and Layout Drawings
3. Exterior panel layout
4. Interior panel layout
5. Bill of Materials
6. PLC I/O list
7. Door-in-door construction devices, where required
8. Sections showing clearances between face and rear mounted equipment.
9. Connection Diagrams.
10. Nameplate engraving schedule:
    a. Indicate engraving by line
    b. Character size
    c. Nameplate size
    d. Panel and equipment tag number and description
11. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.
12. Climate control calculations for each panel
13. Power supply calculations.
14. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Enclosures

1. Pentair/Hoffman Enclosures, Inc
2. Saginaw
3. Rittal
4. Hammond Manufacturing
5. Milbank Mfg. Co.

B. Enclosure Lighting

1. Hoffman LED with IR motion detection.

C. Ethernet Network Switch (Local)

1. Allen Bradley Stratix 2000
2. approved equal.

D. Panel Heaters

1. Pentair/Hoffman Enclosures, Inc.
2. Saginaw
3. Rittal
4. Hammond Manufacturing.

E. Thermostat

1. Pentair/Hoffman Enclosures, Inc.
2. Saginaw
3. approved equal.

F. Ventilation Fans

1. Pentair/Hoffman Enclosures, Inc.
2. Saginaw
3. Rittal
4. Hammond Manufacturing

G. Heater Exchangers

1. Ice Qube, Inc.
2. Hoffman Enclosures, Inc.
3. Rittal.
4. Hammond Manufacturing.

H. Internal corrosion inhibitors:

1. Hoffman Enclosures, Inc.: Model A-HCI.
2. Northern Technologies International Corporation (NTIC):

3. Model Zerust VC.
4. Cortec Corporation: Model VpCl Emitting Systems.

2.2 FABRICATION

A. General:

1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.

2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents. Only NEMA Type 4X will be accepted for installation in the field. NEMA 12 will be acceptable in air- conditioned electrical rooms.

3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.

4. Short circuit current rating of panel:

   a. 10,000A, minimum.

5. Panels and pedestals to be located outdoors shall be fabricated from 316 stainless steel and shall utilize appropriate hinge and locking components. Panel(s) shall be completely assembled at the Systems integrator factory:

   a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.

6. Painting:

   a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted:

      1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.

      2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.

      3) Utilize solvent or chemical methods to clean panel surfaces.

      4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.

5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.

6) Bake powder coating at high temperatures to bond coating to enclosure surface.

a) Panel interior shall be white with semi-gloss finish.

b) Panel exterior shall be ANSI #61 gray with flat finish.

7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 12 rated panels

b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.

7. Finish opening edges of panel cutouts to smooth and true surface conditions:

a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.

8. Panel shall meet all requirements of UL 508A

a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, unless otherwise required by UL 508A, provide a cautionary marking with the words "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."

9. Provide control panel in accordance with NEC Article 409 - Industrial Control Panels:

a. In the event of any conflict between NEC Article 409 and UL 508A, the more stringent requirement shall apply.

10. Panel shall meet all requirements of UL 698A if installed in an in a hazardous rated area or is or used with controls or instrumentation located in a hazardous rated area.

a. Provide intrinsically safe circuit extensions from panels in unclassified locations into hazardous classified locations in accordance with the NEC as required by UL 698A.

11. Panel door handles shall be lockable with a paddle lock. Verify acceptable shank diameter and lock sizes with the city.

B. Wall Mount, Free-Standing or Pedestal-Mounted Panels:

1. Welded construction.

2. Completely enclosed, self-supporting and gasketed dust-tight.

3. Rolled lip around all sides of enclosure door opening.

4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.

5. Full height, fully gasketed flush pan doors.

6. Full length piano hinges rated for 1.5 times door plus instrument weight.

7. Doors with 3-point latch and L-shaped, quarter-turn padlockable handles.

8. Appropriate conduit, wiring, and instrument openings shall be provided.

9. Lifting eyebolts:

   a. To allow simple, safe rigging and lifting of panel during installation.

   b. If removed, plug holes and store eyebolts inside respective enclosure.

10. Enclosures shall be constructed of a minimum of 12-gauge stainless steel.

11. Where double doors are provided, provide removable center post.

C. Internal Panel Lighting and Service Receptacles:

1. One (1) electrical GFCI duplex receptacle for each 3-FT of panel face.

2. One (1) 12-inch 12 VDC or 30 VDC LED strip light fixture with door-activated switch (es) per FT of panel face. Model: Hoffman LED with mounting accessories and connectors; or approved equal.

D. Component Mounting and Placement:

1. Components shall be installed per manufacturer instructions. Double-faced tape will not be permitted.

2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.

3. Terminal blocks shall be mounted vertically in the enclosure with ample clearance to allow visual guidance for installing wires.

4. Front panel devices shall be mounted within a range of 40 to 70 inches above the finished floor or grade, unless otherwise shown in the Contract Documents.

5. PLC and I/O rack installation:

    a. Located such that the LED indicators and switches are readily visible with the panel door open.

    b. Located such that calibration, repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.

    c. Locate power supplies with sufficient spacing for circulation of air.

    d. Where components such as relays, and other electromagnetic devices are installed within the same enclosure as the PLC system components, provide a barrier of at least 6-inch of separation between the “power area containing the electromagnetic devices” and the “control area”.

6. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws:

    a. Fastening devices shall not project through the outer surface of the panel enclosure.

7. Locate and install all devices and components so that connections can be easily made and ample room is provided for servicing each item

8. OITs shall be installed at 5’2” to center of screen for finished floor or walkway directly in front of the install location. In the event mounting height is unclear due to other information or situations, Contractor shall submit an RFI to verify desired mounting height before proceeding with installation.

E. Follow UL recommendations.

2.3 INTERNAL WIRING

A. See Section 40 67 33

2.4 SPARE PARTS

A. Spare parts are to be provided in accordance with 40 61 13

B. Tag and store spare parts in accordance with Section 40 61 13.

C. Provide 20 percent spare contiguous sub-panel area for future expansion.

PART 3 EXECUTION

3.1 TEST PLANS AND REPORT

A. The Contractor shall be required to prepare and submit for review and approval the following:

1. Factory Acceptance Test Plan and procedures.

2. Site Acceptance Test Plan and procedures.

3. Test Schedules.

4. Test Reports.

5. Instrument and (applicable) component calibration sheets.

3.2 FACTORY TESTING

A. Factory Acceptance Test (FAT) and verification for all deliverable equipment, programs, and associated documentation shall be performed prior to shipment of the system. The tests shall verify that the equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements. The tests shall verify that the software and hardware meet the functional and performance requirements of the project. The FAT shall be performed at the Contractor's factory and shall be witnessed by Owner personnel.

B. Testing requirements shall be part of every PLC installation. The Contractor shall demonstrate the system was fully tested during development and installation.

3.3 INSTALLLATION

A. Mount and shim to precise alignment floor mounted control panels so doors operate without binding. Provide sealant for conduit entering the panels.

1. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

2. Provide sunshields where shown on the Drawings.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2 inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with 26 27 16.

C. Spray terminals and terminal blocks after all terminations have been completed with a silicone resin similar to Dow Corning R-4-3117 conformal coating. Spray coating only required for control panels in corrosive or classified installation environments.

D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

E. Vacuum clean control panels and cabinets.

3.4 SITE ACCEPTANCE TESTING

A. PROCEDURES: Section 40 61 21

B. The following testing is in addition to Section 40 61 21 requirements for the preoperational test phase and component test phase.

C. A System Acceptance Test (SAT) and a System Operational Acceptance Test (OAT) shall be performed at the site. The final documentation will then be reviewed for completeness. Site Acceptance Testing shall be witnessed by the city's personnel.

D. The SAT shall include the requirements as follows:

1. The acceptance test shall verify that the equipment and all cables have been properly installed, have not been damaged, and have not failed in shipment or storage.

2. The acceptance test shall demonstrate stable operation of all PLC I/O modules, wiring, and data transmission to the OIT under actual operating or simulated conditions. The test shall also demonstrate proper operation of all digital or sequential control. All start/stop, open/close, raise/lower and similar commands and all discrete status inputs shall be tested for proper operation. In addition, all alarms, both analog and discrete, shall be tested.

E. The System OAT shall require the testing of system functions, software, and performance in hand-only mode after completion of all site installation tests. These tests shall verify complete operation of the system or site, including additional tests required to verify field-installed equipment, which was not available at the factory. The Contractor shall be required to perform the following:

1. Verify the facility installation.

2. Verify the SAT.

3. Verify operation of any local operator interface device.

END OF SECTION

SECTION 40 67 33 - PANEL WIRING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Installation
6. Testing

1.2 SCOPE

A. This section specifies wiring requirements for wiring of process control panels.

B. Comply with the specified products in Sections 40 61 13 and 40 67 16. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.

C. All panel wiring is to be completed within a UL 508A certified fabrication facility. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.

D. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that may include motor controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

E. Submittals as specified in Section 01 33 00 and Section 40 61 13.

1.3 REFERENCE STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

1. American National Standards Institute (ANSI).

2. ASTM International (ASTM):

    a. B75, Standard Specification for Seamless Copper Tube.

3. National Electrical Manufacturers Association (NEMA):

    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

    b. ICS 4, Industrial Control and Systems: Terminal Blocks.

4. National Fire Protection Association (NFPA):

    a. 70, National Electrical Code (NEC).

5. Underwriters Laboratories, Inc. (UL):

    a. 508A, Standard for Safety Industrial Control Panels.

    b. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

    c. 698A, Industrial Control Panels Relating to Hazardous (Classified) Locations.

1.4 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

1. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

C. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

1.5 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

C. Entire assembly shall be affixed with a UL 508A or 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

D. Each panel shall have an affixed fuse identification list.

E. Each panel shall have an affixed power and short circuit rating label.

1.6 SUBMITTALS

A. PROCEDURES: Section 01 33 00 and 40 61 13

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Submittal items required include:

1. Wire Types
2. Labeling materials and methods
3. Wiring lugs
4. Wireways
5. Hinge wiring method description

6. Wire colors

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION

3.1 INTERNAL PANEL WIRING

A. Arrange wiring neatly, cut to proper length, with surplus wire removed:

1. Arrange wiring with sufficient clearance.

2. Provide abrasion protection for wire bundles that pass-through openings or across edges of sheet metal.

B. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DegC:

1. Conductor size shall be as required for load and 16 AWG minimum. Conductors for power wiring shall be sized for load and 14 AWG minimum.

2. Internal panel wiring color code:

a. 120 VAC circuits:

1) Power wiring: Black

2) Control circuits: Red

3) Neutral: White

4) Ground: Green

3. Low voltage DC circuits (typically 24 V):

a. DC Control (+): Blue

b. DC Control, Common (-): White-Blue Stripe

4. Unless otherwise required by UL.

C. Splicing and tapping of wires permitted only at terminal blocks

D. Wire bundles shall be secured using plastic tie wraps except within wiring ducts. The bundles shall be securely fastened to the steel structure at intervals not exceeding 12-inches using appropriately sized stainless-steel machine screws.

E. Wires shall be supported by means other than the connectors or terminal strips. Wires shall be contiguous from connector to connector without wire splices between them.

F. Wiring shall be installed such that if wires, including neutral/common wires, are removed from one (1) device, source of power will not be disrupted to other devices.

1. AC circuits:

a. Routed separate from analog signal cables and DC signal wires or cables.

b. Separate by at least 6 inches, except at unavoidable crossover points and at device terminations.

2. Analog signal cables carrying low level signals of 100 millivolts or less shall not be run in the same bundle, duct, or wire duct as digital input or control output wiring.

G. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.

H. Analog signal cables shall be of 600 V, 90 deg C rated insulation, with stranded copper wire in twisted-shielded pairs:

1. The cable's outer diameter shall be 0.25 inch maximum with 100 percent coverage aluminum foil mylar-lined shield and 22 AWG minimum stranded tinned copper drain. The cable shall be UL listed.

2. Conductor size: 18 AWG minimum.

3. Terminate shield drain conductors to ground only at one (1) end of the cable. The drain wire shall not be used as a control signal conductor. It shall be terminated at a terminal strip or trimmed back to the jacket of the shielded cable, as required by its application.

4. Shields that are connected to ground shall either be tinned by solder or have heat shrink insulation installed over the wires to prevent stray strands from reaching ground or shorting to other terminals.

I. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip:

1. Route wiring within the panel in wire-duct as possible

2. Follow wire-duct manufacturers recommended fill limits. In addition, raceways must meet fill requirements per UL 508A and NEC.

3. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.

4. Wire-duct shall be Panduit Type E or NE, constructed of nonmetallic materials, and rated in excess of the maximum voltage carried therein.

J. Wire-duct shall be supported by appropriately sized plastic rivets or screws which have been tapped into the subpanel.

K. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire:

1. Protect bend area with sleeve.

L. Provide surge protection for analog inputs from field (remote) devices

M. No more than two connections made to one terminal.

N. Wire and cable identification:

1. Wire and cables numbered and tagged at each termination.

2. Wire tags:

a. Slip-on shrink fitted plastic wire sleeves with legible, machine- printed markings.

b. Adhesive, snap-on, or adhesive type labels are not acceptable.

c. Provide at both ends, except for pre-terminated cables with connectors.

d. Markings as identified in the shop drawings

O. Grounding Requirements:

1. Each panel shall be provided with two copper ground bars:

2. One bar (standard panel system ground bus) shall be bonded to the panel frame or sheet metal and to the station ground system.

3. The second bar (signal ground bus) shall be mounted on insulated stand- offs and shall be bonded to the frame ground bar at one point only.

3.2 TESTING

A. FACTORY TESTING:

1. Prior to shipment, the manufacturer tests the functional operation of the control panels as described in Section 40 61 21.

2. Complete point to point testing and verification of each wire.

3. The Owner requires the factory test to be a witnessed test. The Contractor shall include in the bid price the expense for travel and accommodations for one (1) representative from the Owner to witness the factory test at the manufacturer's facility. If test results require the testing to be redone, the additional costs for additional testing shall be borne by the Contractor.

B. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00

END OF SECTION

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SECTION 40 68 66 - PROGRAMMING OF CONTROLLER SOFTWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Product Requirements
7. Installation
8. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and configuration of the PLC programming to support project specific requirements. This includes testing, documenting, and start up.

B. The system shall be configured to provide the control capabilities and functions indicated and implied by the Plans and these Specifications and to provide trouble-free operation with minimum maintenance. The system shall readily enable manual operation of any and all functions in the event of failure of any one component.

1. The control system shall be designed and assembled by the Control System Integrator to provide:

a. Control of motor driven pumps, equipment, and processes.

b. Monitoring of operation of motor driven pumps, equipment, and processes.

c. Indication of operating status of motor driven pumps, equipment, and processes.

d. Monitoring and indication of pressures, temperatures, levels, and flows, as indicated and implied by the plans and specifications.

e. The capabilities indicated and implied by the plans and specifications.

C. The City's Control System Integrator, Simtek Industrial Controls and Automation, LLC, shall provide all software, programming, configuration, testing, adjusting, and miscellaneous effort required for a complete, workable and integrated control system.

D. PRE-SUBMITTAL CONFERENCE:

1. Schedule a pre-submittal conference with the Owner and Engineer within 30-calendar days after Contract award to discuss the PLC programming.

1.3 DEFINITIONS

A. SYSTEMS INTEGRATOR: A firm engaged in the business of detailed control system design and engineering, custom panel fabrication, instrumentation component purchase, instrumentation tuning, system and panel assembly, PLC and HMI or SCADA programming and testing the specified process control and industrial automation systems.

B. SYSTEMS PROGRAMMER: Employee of the SYSTEMS INTEGRATOR providing the PLC and SCADA application programming.

C. HMI: Acronym for Human Machine Interface

D. OIT: Acronym for Operator Interface Terminal

E. SCADA: Acronym for Supervisory Control and Data Acquisition

F. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. System Responsibility:

1. Responsible for control of the supplied process equipment to provide the established level of performance and quality.

2. Provide pre-submittal and on-site design reviews with the Owner and Engineer

3. Coordinate with the Owner and Engineer to assure seamless integration of required additional equipment into the overall Plant SCADA system.

C. Programmer Qualifications

1. Provide qualified staff to support the programming and startup of the PLC programming modifications.

    a. Provide an on-site qualified specialist experienced with the specified control equipment and with experience providing a leadership role when implementing process control systems. Must have a minimum of five years' experience or at least five separate projects. This experience would include managing, testing, commissioning and training as it relates to programming of PLC for similar equipment and processes.

    b. Provide programming personnel that has a minimum of three years of programming experience with the specified equipment and processes.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Submittals and PLC/OIT programming shall not relieve the Contractor of responsibility for errors that may be contained herein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Submittals and SCADA screens, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. PLC and OIT programs:

    a. Description of proposed screens including the following data:

        1) Description of proposed screen layout.

        2) Description of graphic symbols used to represent process equipment.

        3) Displayed I/O points.

        4) Displayed operator configurable parameters and setpoints.

        5) PLC ladder logic for alarms, pump control and monitoring

            a) Clearly indicate the manner in which PLC program will be structured and how it will be documented.

3. Proposed testing procedures including proposed test report forms.

4. Execution plan including schedule.

1.6 PERFORMANCE REQUIREMENTS

A. Work involved in this contract includes providing PLC, OIT, and SCADA Programming to conform to operational narratives provided by design team, as shown on the Plans, and described herein.

B. Provide complete and operational PLC, OIT, and SCADA programming that provides operation similar to the city's existing systems. This includes the following:

1. Monitor and control of the four booster pumps and Fill Station in the new pump station.

2. Monitor and control of the control valves in the new pump station as shown in the drawings.

3. Monitoring of flow meters, pressure sensors, backup generator, Automatic Transfer Switch, and other instrumentation as shown in the drawings.

C. Interface new equipment into the existing SCADA system and program OITs in a manner consistent with existing control systems throughout the city. This includes, but not limited to:

1. Equipment control and visualization

2. Setpoint adjustments

3. Data logging and reporting

4. Alarming

D. PLC Program Formatting:

1. Match existing programming patterns.

2. Programming language shall be Ladder Logic.

3. Program documentation shall include tag names, descriptions and rung comments as required to optimize readability and understanding of PLC programming code.

E. The design, application, and installation of the PLCs shall conform to NEMA ICS 1.1.

PART 2 PRODUCTS

2.1 PLC PROGRAMMING SOFTWARE

A. Rockwell Automation's RS Logix 5000 with version support for the PLC as specified in the drawings. If the City's software licensing does not provide support of the PLC, an update to the licensing shall be required.

2.2 OIT PROGRAMMING SOFTWARE

A. Rockwell Automation's FactoryTalk View Studio Machine Edition with version support for the OITs as specified in the drawings. If the City's software licensing does not provide support of the OITs, an update to the licensing shall be required.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

B. Contractor will schedule a date and time for start-up and will have the following people present.

1. General Contractor
2. Electrical Contractor
3. Owners' representative
4. Engineer

C. PLC, OIT and SCADA system programming shall be installed, calibrated, and tested on-site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration and verification shall be conducted by a qualified System Integrator.

D. CONTRACTOR shall provide the services of the programmer for a minimum of five days for the calibration and testing of the PLC and I/O at start up.

E. In addition, the PLC, OIT, and SCADA system programming shall be operationally tested in conjunction with the functional acceptance test of Instrumentation and Controls for the completed system.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation of the PLC and I/O so as to not result in false readings, failed control, or improper operation due to ambient conditions, electrical noise, EMI or RFI interference, and other equipment at the installation site.

C. Complete Testing Procedures and Forms submitted and approved by Systems Integrator under section 1.5 above.

END OF SECTION

SECTION 40 71 36 - TURBINE FLOW METERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Product Requirements
7. Installation
8. Testing
9. Manufacturer's Services

1.2 SCOPE

A. This Section specifies requirements for supply and installation of the Turbine Flow Meter measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

    a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

    b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided.

        1) Must include:

            a) Dimensional Drawings

            b) Materials of Construction

                (1) Turbine flow meter
                (2) Flanges

(3) Process Connection

2) Accuracy

3) Range

4) Environmental Rating

5) Classification Rating

6) Power Requirements

7) Output Options

D. Manufacturer's installation instructions, including mounting requirements.

E. Operation and maintenance information.

F. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 61 13

B. OPERATING CONDITIONS: Section 40 06 70 Instrument Schedules.

C. This section specifies requirements for supply and installation of Turbine Flow Meters listed in Section 40 06 70 Schedules of Instrumentation for Process Systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Turbine Flow Meter candidate manufacturers and models:

1. Recordall Turbo Series Meter Model 450 with Badger Meter HR-LCD Register/ Transmitter

2. Approved equal by Project Engineer

3. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Turbine flow meter provided as a system consisting of a flow tube with local mounted register / indicating transmitter as listed in the instrument schedule or as shown on the

drawings. At least one programming kit and programming cables is required for setup and diagnostics from a personal computer and shall be included with the system(s).

B. Transmitter specified is to comply with Section 40 61 13 transmitter requirements.

2.3 FLOW METER

A. Direct magnetic drive with interchangeable, unitized measuring element, and permanently sealed mechanical register.

B. Construction in compliance with ANSI and AWWA C701 standards

C. Lead-free alloy Meter Housing and Turbo Head.

D. Integral Strainer with NPT test port.

E. Meter Flange Process Connection: 3 in. AWWA 125 Pound Class

F. Specifications:

1. Typical Operating Range: 5…550 gpm

2. Typical Low Flow : 4 gpm

3. Max. Flow: 450 gpm Continuous / 550 gpm Intermittent

4. Pressure Loss: 7.3 psi (17.8 psi with strainer)

5. Max. Operating Pressure: 150 psi (10 bar)

6. Max. Operating Temperature: 120° F (49° C)

2.4 HR-LCD REGISTER/TRANSMITTER:

A. The register/transmitter shall be Badger HR-LCD 4-20mA.

B. Programming can be performed through the IR programming port via a computer using the Programmer software, version 2.0.0 or greater.

C. Specifications:

1. Battery: Lithium thionyl chloride AA cell, fully encapsulated within register housing.

a. Battery Life 10 years based on default settings and typical operating range.

2. Register Display: Status indicators, unit of measure, billing units, automatic toggle between 9-digit consumption, rate of flow, meter model.

3. Unit of Measure: U.S. gallons, Imperial gallons, cubic feet, cubic meters, and liters.

4. Flow Rate: Seconds, minutes, and hours.

5. Temperature

    a. Storage: – 40…140° F (– 40…60° C)

    b. Max. ambient for 1 hr: 150° F (66° C)

    c. Electronics & Display: 14…140° F (–10…60° C)

6. Visual icons Status Indicators: meter functioning correctly, meter alarm (indicates temperature limits exceeded, magnetic tamper or register removal), reverse flow, suspected leak, 30-day no usage, end of battery life.

7. Transmitter Outputs:

    a. Scaled/Unscaled Solid-state relay: 30vdc Max./100mA. Pulse Width 50ms (programmable 30…100ms)

    b. 4-20mA Analog Output: Two-wire/passive. 9…50V DC supply/500 Ohms

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13

B. Install all components of Turbine Flow Meters system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

C. Ensure proper installation of the Turbine Flow Meters system so as to not result in false reading due to ambient conditions or equipment at the installation site.

D. Comply with mounting details provided on the drawings.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Instruments shall be tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. A qualified System Integrator shall confirm factory calibration and verify process data scaling within the PLC.

C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

B. CONTRACTOR shall provide the services of a qualified System Integrator minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 71 66 - TRANSIT TIME FLOW METERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Product Requirements
7. Installation
8. Testing
9. Manufacturer's Services

1.2 SCOPE

A. This Section specifies requirements for supply and installation of the Transit Time Flow Meter measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

A. UL – Underwriters Laboratory approved
B. ASTM – American Society for Testing and Materials
C. NEMA – National Electrical Manufacturer's Association
D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

   a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

   b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

   a. Mark data sheets to clearly show exact product and options being provided.

      1) Must include:

         a) Dimensional Drawings

         b) Materials of Construction

            (1) Transducer
            (2) Mounting Hardware to include Index rails, clamp, hooks and chains

c) Accuracy

d) Range

e) Classification Rating

f) Electronic Transmitter:

(1) Enclosure Rating
(2) Power Requirements
(3) Output Options

D. Manufacturer's installation instructions, including mounting requirements.

E. Operation and maintenance information.

F. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 61 13

B. OPERATING CONDITIONS: Section 40 06 70 Instrument Schedules.

C. This section specifies requirements for supply and installation of Transit Time Flow Meters listed in Section 40 06 70 Schedules of Instrumentation for Process Systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Transit Time Flow Converter candidate manufacturers and models:

1. Panametrics AquaTrans AT868

2. Approved equal by Project Engineer

3. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Transit Time flow meter provided as a system consisting of an Electronic Transmitter, Transducer and mounting hardware.

B. System Performance Specifications:

1. Pipe sizes: 0.5 to 300 in. (12.7 mm to 7.6m) and larger

2. Pipe-wall thickness up to 3 in (76.2 mm)

3. Pipe materials: All metals and most plastics.

4. Typical clamp-on flow accuracy (velocity)

   a. Pipe ID>6 in (150 mm): ±1% to 2% of reading

   b. Pipe ID<6 in (150 mm): ±2% to 5% of reading

5. Repeatability: ±0.1% to 0.3% of reading

6. Range (bidirectional): –40 to 40 ft/s (–12.2 to 12.2 m/s)

7. Rangeability (overall): 400:1

   a. Specifications assume a fully developed flow profile (typically 10 diameters upstream and 5 diameters downstream of straight pipe run) and flow velocity greater than 1 ft/s (0.3 m/s).

2.3 ELECTRONIC TRANSMITTER:

A. The transmitter shall be a microprocessor controller mounted remotely as specified in the instrument schedule. The transmitter shall incorporate a 85 to 265 VAC, 50/60 Hz or 12 to 28 VDC power supply. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

B. The transmitter shall retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure. The memory unit shall be transferrable from a damaged unit or used for a duplicate device with no loss of device parameters.

C. The transmitter shall include a 2-line x 16-character backlit LCD display, configurable to display up to four measurement parameters in sequence. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages.

D. The transmitter shall include a six-button internal keypad to allow for local programming.

E. The transmitter shall include an RS232 Interface for use with programming software to allow user to:

1. Load and save site file data

2. Create and save graphs and log files

3. Display text output and graphs of live measurement data

4. Create custom templates for displaying text, graphs and log data

5. Interface with multiple instruments.

F. The measurement signals from the transducers to the transmitter shall be conducted up to 1000 feet to the transmitter. See plan drawings for estimated length required.

G. The transmitter output(s) shall be integral to the Transit Time flowmeter electronics. Using an external third party signal converter is unacceptable.

H. The transmitter output shall provide 4-20 mA output as well as a totalizing pulse

1. Pulse output selectable settable for flows from 1 to 500 gallons per pulse.

2. The basic outputs can be altered in the field by programming. All outputs shall be galvanically isolated from each other and all other circuits.

3. The transmitter shall provide the capability to test all outputs for proper operation to assist in commissioning.

I. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

J. The transmitter shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 20W.

K. Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

2.4 ULTRASONIC FLOW TRANSDUCERS:

A. Temperature range: -40°F to 302°F (-40°C to 150°C)

B. Mountings: Stainless steel chain or strap, welded or magnetic clamping fixtures.

C. Environmental Rating: submersible IP67/68

1. Optional Class I, Div1 Explosion Proof if specified in the drawings or Instrumentation List.

Cable Assemblies: Provide manufacturer cable assemblies for termination to the Electronics transmitter. See drawings for estimated length.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13

B. Install all components of Transit Time Flow Meters system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

C. Ensure proper installation of the Transit Time Flow Meters system so as to not result in false reading due to ambient conditions or equipment at the installation site.

D. Comply with mounting details provided on the drawings.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Instruments shall be tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. A qualified System Integrator shall confirm factory calibration and verify process data scaling within the PLC. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

B. CONTRACTOR shall provide the services of a qualified System Integrator minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 73 26 - GAUGE PRESSURE TRANSMITTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Products Requirements
7. Installation
8. Testing
9. Manufacturer's Services

1.2 SCOPE

A. This Section specifies requirements for supply and installation of Gauge Pressure and measuring system(s). This includes testing, documenting, and start up.

B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.

C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ICS-1 – Industrial Control and Systems General Requirements

G. ICS-2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

H. ICS-3 – Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

I. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1.4 1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

    a. Mark data sheets to clearly show exact product and options being provided.

D. Manufacturer's installation instructions, including mounting requirements.

E. Operation and maintenance information.

F. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 61 13

B. OPERATING CONDITIONS: As specified herein and on the drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Pressure Transmitter candidate manufacturers and models:

1. NOSHOK model 621 or 622

2. Approved equal by Project Engineer.

3. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

A. Pressure measurement provided as a system consisting of a pressure transmitter with integral process connection.

B. Transmitter specified is to comply with Section 40 61 13 transmitter requirements.

C. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

2.3 FEATURES

A. Process Connection: as shown on the drawings.

B. System error shall not exceed ± 0.25% of range

C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.

D. Temperature Range: -20 to 60 ºC minimum (Operating) 0 to 50ºC (Compensated).

E. Environmental Ratings: IP67

F. Transmitter Materials:

G. Body: Welded 316 stainless steel.

H. Transmitter to be FM approved for Class I & II, Div. 1 Groups A, B, C & D.

2.4 ELECTRICAL REQUIREMENTS

A. Input current: 20 mA max (loop Power)

B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in measured value.

C. Insulation resistance: 100 Mega Ω @ 50 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.

D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13

B. Install all components of pressure measuring system in accordance with manufacturer's specifications and instructions for the specified functional requirements.

C. Comply with mounting details provided on the drawings.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Instruments shall be tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. A qualified System Integrator shall confirm factory calibration and verify process data scaling within the PLC.

C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

B. CONTRACTOR shall provide the services of a qualified System Integrator for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

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SECTION 40 77 00 - POSITION AND MOTION MEASUREMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Product Requirements
6. Installation
7. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and installation of lever operated switches as shown on the drawings

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ISA – Instrumentation, Systems, and Automation Society.

G. ICS-1 – Industrial Control and Systems General Requirements

H. ICS-2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

I. ICS-3 – Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 61 13

B. OPERATING CONDITIONS: Suited for location shown or the drawings or listed in Section 40 06 70's instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Lever Operated Switches candidate manufactures and models:

1. Cutler-Hammer, Model E50AR1 with E50KL537 adjustable

2. Allen Bradley, No. 802X-124 or 802X-114 with No. 802T-W2 roller levers;

3. Approved equal

2.2 GENERAL

A. Lever Operated Switches shall be provided where indicated, specified, or required to meet the functional requirements of the system.

B. Lever Operated Switches shall be provided with necessary brackets and clamps to affix the unit where required. All mounting clamps shall be Stainless Steel.

C. Switch shall include a switch body, lever and rollers.

D. Electrical connection as required for installation locations shown on the drawings.

2.3 FEATURES

A. Automatic Spring Return Lever

B. Adjustable level length of 1 3/16 to 3 inch minimum with Nylon ¾ inch diameter roller.

C. Enclosure NEMA 4X

2.4 ELECTRICAL REQUIREMENTS

A. Level operated limit switch

B. DPDT Contacts rated 5 amps at 120 VAC

2.5 ACCESSORIES

A. Connector, cable and stainless-steel mounting bracket.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

A. Install all components of switches in accordance with manufactures specifications and instructions.

B. Switches shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer’s recommendations.

C. In addition, the switches shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Verify lever operated switch makes when valve opens when installed as a valve open limit switch.

C. Verify switch is makes upon closing of door or hatch and breaks upon opening of door or hatch.

D. Verify lever operated switch makes upon opening of check valves when installed as check valve limit switch.

END OF SECTION

SECTION 40 78 16 - INDICATING LIGHTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Product Requirements
6. Installation
7. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and installation of indicating lights

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ISA – Instrumentation, Systems, and Automation Society.

G. ICS-1 – Industrial Control and Systems General Requirements

H. ICS-2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

I. ICS-3 – Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

J. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1. Standard 508A (Industrial Control Panels for General Use).

2. Standard 698A (Industrial Control Panels Relating to Hazardous (Classified) Locations)

3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)

K. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 67 16 and 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

A. Submittal requirements specified in: Section 01 33 00.

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements,

with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 GENERAL

A. Pilot Devices shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. All Pilot Devices shall meet the following minimum specifications, unless otherwise noted.

1. All pilot devices shall be of heavy-duty, metallic, type 4/13, watertight/oiltight construction. Units shall mount through a 30.5 mm round hole.

2. All pilot devices shall have custom legends as shown on the drawings. Legends shall be black with white letters, and letter height shall be minimum 3/16-inch-high characters.

3. All button and lens colors shall be as shown on the drawings. Color code is as follows:

4. A = Amber, B = Blue, G = Green, R = Red, Y = Yellow, W = White

5. All pilot devices shall be equipped with a sufficient number of contact blocks to accomplish the switching functions specified.

B. Indicating lights shall meet the following minimum specifications, unless otherwise noted.

1. All indicating lights shall be full voltage type with LED lamps. Units shall be rated for the voltage shown on the drawings.

2. All indicating lights shall be "push-to-test" type.

3. All indicating light lenses shall be plastic.

C. Candidate manufacturers and models include the following

1. Allen-Bradley, Bulletin 800T.

2. Square D. Co., Type TA

3. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

B. Install per manufacturer’s instructions.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation per manufacturers recommendations

3.3 MANUFACTURER’S SERVICES

A. REQUIREMENTS: Section 40 61 13 and 40 61 26

END OF SECTION

SECTION 40 78 19 - SWITCHES AND PUSH BUTTONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Product Requirements
6. Installation
7. Testing

1.2 SCOPE

A. This Section specifies requirements for supply and installation of push buttons and indicating lights

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer's Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ISA – Instrumentation, Systems, and Automation Society.

G. ICS-1 – Industrial Control and Systems General Requirements

H. ICS-2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

I. ICS-3 – Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

J. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1. Standard 508A (Industrial Control Panels for General Use).

2. Standard 698A (Industrial Control Panels Relating to Hazardous (Classified) Locations)

3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)

K. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

C. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Candidate manufacturers and models include the following

1. Allen-Bradley, Bulletin 800T.

2. Square D. Co., Type TA

3. Approved Equal

2.2 GENERAL

A. Pilot Devices shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. All Pilot Devices shall meet the following minimum specifications, unless otherwise noted.

1. All pilot devices shall be of heavy-duty, metallic, type 4/13, watertight/oiltight construction. Units shall mount through a 30.5 mm round hole.

2. All pilot devices shall have custom legends as shown on the drawings. Legends shall be black with white letters, and letter height shall be minimum 3/16-inch-high characters.

3. All button and lens colors shall be as shown on the drawings. Color code is as follows:

4. A = Amber, B = Blue, G = Green, R = Red, Y = Yellow, W = White

5. All pilot devices shall be equipped with a sufficient number of contact blocks to accomplish the switching functions specified.

6. All selector switches shall be knob type.

7. Illuminated selector switches shall be 120-volt AC, full voltage type with LED lamps where specified.

B. Pushbuttons shall meet the following minimum specifications, unless otherwise noted.

1. All pushbuttons shall be flush type.

2. All emergency stop pushbuttons shall be red colored, jumbo mushroom head, push operate / twist release type, with one form C contact, minimum. Emergency stop pushbutton legends shall be red with white letters, and letter height shall be minimum 3/16-inch-high characters.

3. Unless otherwise shown, all other pushbuttons shall be black in color.

4. Illuminated push buttons shall be 120-volt AC, full voltage type with LED lamps where specified.

C. Indicating lights shall meet the following minimum specifications, unless otherwise noted.

1. All indicating lights shall be full voltage type with LED lamps. Units shall be rated for the voltage shown.

2. All indicating lights shall be "push-to-test" type.

3. All indicating light lenses shall be plastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

B. Install all components in accordance with manufactures specifications and instructions.

C. Components shall be installed and tested on site in accordance with the requirements of Section 40 61 13 and in accordance with the manufacturer’s recommendations.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Ensure proper installation per manufacturers recommendations

END OF SECTION

SECTION 40 78 53 - RELAYS/TERMINAL BLOCKS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Quality Assurance
3. Reference Standards
4. Submittals
5. Performance Requirements
6. Products
7. Installation
8. Testing

1.2 SCOPE

A. This section specifies requirements for Auxiliary Relays used for control signal isolation and Terminal Blocks used for control conductor termination installed in control panels andnd junction boxes.

1.3 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials

B. NEMA – National Electrical Manufacturer’s Association

C. NEC – National Electrical Code

D. NFPA No. 70, NEC - National Electrical Code

E. NFPA No. 79, Electrical Standard for Industrial Machinery.

F. ICS-1 – Industrial Control and Systems General Requirements

G. ICS-2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

H. ICS-3 – Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

I. ICS 4 : Application Guideline for Terminal Blocks

J. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1. Standard 508A (Industrial Control Panels for General Use).

2. Standard 698A (Industrial Control Panels Relating to Hazardous (Classified) Locations)

3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)

K. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

B. The manufacturer shall warranty the specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

a. Mark data sheets to clearly show exact product and options being provided

D. Manufacturer's installation instructions.

E. Operation and Maintenance Manual if applicable.

F. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

A. RELAYS:

1. OPERATING CONDITIONS: Environmental and Hazardous Location ratings shall be determined by the ratings of the control apparatus for the installation where used. Where Relay does not meet these requirements a suitable enclosure shall be provided to meet the requirements.

B. TERMINAL BLOCKS:

1. OPERATING CONDITIONS: Environmental and Hazardous Location ratings shall be determined by the ratings of the control apparatus for the installation where used. Where Terminal block does not meet these requirements, a suitable enclosure must be provided that meets the requirements.

2. Terminal block shall be rated for the Voltage, Amperage, and Conductor size for the application requirements.

PART 2 PRODUCTS

2.1 RELAY CANDIDATE MANUFACTURERS

A. Power and Master Control Relays

1. Allen Bradley 700P/PK
2. Square D 8501X/XM
3. Approved Equal

B. Plug-in Interposing/Auxiliary Relays

1. Idec RR/RJ Series
2. Allen Bradley, Bulletin 700-HA/700-HB/700-HK
3. Phoenix PLC-RIF/RSC
4. Approved Equal

C. Terminal Block Style Interposing/Auxiliary Relays

1. Idec RV8H series
2. Allen Bradley, Bulletin 700-HLT
3. Phoenix DEK
4. Approved Equal

    a. Units used with PLC outputs to be provided with leakage current suppression circuitry.

D. Timing Relays for Auxiliary Control

1. Allen Bradley 700-FS/HR
2. Approved Equal

E. Terminal Blocks

1. Allen-Bradley – 1492 J series
2. Phoenix Contact – UK 5 series
3. Entrelec
4. Approved Equal

2.2 RELAYS GENERAL

A. Relay contact ratings shall be evaluated for rated Voltage and Amperage per application needs to obtain minimum operational cycles:

1. Power and Master Control Relays

    a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.

2. Plug-in Interposing/Auxiliary Relays

    a. a. 100,000 operations minimum at rated load.

3. Terminal Block Style Interposing/Auxiliary Relays

    a. 1,000,000 mechanical operations and 100,000 minimum electrical operations at rated load.

4. Timing Relays for Auxiliary Control

    a. a. 1,000,000 mechanical operations and 100,000 electrical operations at rated load.

5. Submersible Pump Thermal/Leakage Relay

    a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.

B. Plug-in and Terminal Block Style Interposing/Auxiliary relays shall Equipped with a push-to-test button and indicator light.

C. Coil voltage shall match the control circuit voltage.

2.3 TERMINAL BLOCKS

A. GENERAL:

1. Terminal blocks shall be one-piece, molded, plastic blocks with screw-type terminals and barriers rated for 600 volts.

2. Unless otherwise specified, terminal blocks shall be cage clamp screw type. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the drawings.

3. Units must be rated for ampacity of wiring connected.

    a. Minimum 20 amps unless otherwise noted.

4. Terminals shall be tin-plated. Insulating material shall be nylon.

5. Provide jumper bars for jumpering between terminal blocks.

6. Provide end clamps to separate and terminate terminal block groups. Provide end covers for groups of terminal blocks in sets to match the number points associated with individual I/O cards in the PLC block.

7. Provide Separation Plates on each side of terminals that are at a different potential or polarity than surrounding terminals.

8. Provide clear plastic DIN rail mounted nametag stanchions for each block of terminations. Each nametag shall hold a preprinted label designating the PLC bus and PLC block that terminates to that set of terminals.

9. Terminals shall be mounted such that there is a minimum of 1.5 inches of clear space on both sides of the terminal; for ease of wiring.

10. Provide wired terminals to match the number of points supplied on each installed I/O card or spare slot in a PLC cabinet.

11. Fuse terminal blocks shall be hinged disconnect level type with “blown fuse” indicators.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

B. Components shall be installed and tested on site in accordance with the requirements of Section 40 61 13 and in accordance with the manufacturer’s recommendations.

C. Terminals shall be torqued to manufacturer specifications.

1. Provide terminals for all wire connections to field wiring and internal power distribution.

2. Terminals shall be DIN rail strip mounted. Provide number strips for terminal blocks that are referenced by the wire marker.

3.2 TESTING

A. REQUIREMENTS: Section 40 61 21.

B. Relays shall be tested in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer’s recommendations.

C. In addition, the units shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

SECTION 40 78 59 - POWER SUPPLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Reference Standards
3. Quality Assurance
4. Submittals
5. Performance Requirements
6. Products Requirements
7. Installation
8. Testing

1.2 SCOPE

A. This section specifies requirements for auxiliary Direct Current Power Supplies installed in control panels as specified herein or as shown on the drawings.

B. Comply with the specified products in Sections 40 67 16, 40 67 19, 40 78 00 and 40 67 63. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.

C. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.

D. Refer to Local Control Panels - Section 40 67 16 and 40 67 19 for Free Standing and Wall mounted Panels. These requirements apply to this section as well.

E. Submittal drawing requirements specified in Section 40 61 13.

F. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.3 REFERENCE STANDARDS:

A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of

conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

1.5 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Include product data sheets of equipment, devices, and materials requested by the individual specification sections.

a. Catalog information shall include technical specifications and application information, including ratings, range, weight, accuracy, etc.

4. Catalog cuts shall be edited to show only the items, model numbers, and information which apply

5. Installation instructions, outline dimensions and weights including filters and/or phase shifting autotransformers, front view drawing identifying control and monitoring devices, nameplate engravings, shipping section dimensions, weight, and foundation requirements or wall mounting requirements for all assemblies.

6. External connection diagram showing function and identification of all terminals requiring field connections.

7. O&M manuals per Section 01 33 00 and Section 26 05 00

C. Submittal items required include:

1. Connection Diagrams.
2. Power supply calculations.
3. Product Data: For each type of device and system:

4. Include product data sheets and equipment brochures showing standard products and specified accessories.

1.6 PERFORMANCE REQUIREMENTS

A. REQUIREMENTS: Section 40 67 63.

B. OPERATING CONDITIONS: Section 40 67 63.

PART 2 PRODUCTS

2.1 DIRECT-CURRENT POWER SUPPLIES

A. Convert 120 VAC to 24-volt DC or other DC voltages required as shown on the drawings.

B. Sized to provide 40 percent excess rated capacity.

C. Sized as shown on the drawings as a minimum. Provide calculations to show anticipated load does not exceed 70% of power supply rating.

D. UL 508C listed to allow full rated output without de-rating.

E. FEATURES:

1. Convection-cooled linear type or switching type.

2. Line regulation: 0.4 percent for line variations from 105 to 132 volts.

3. Load regulation: 0.4 percent for load variations from 0 to full load.

4. Output regulation: Within 0.05 percent for a 10 percent line change or a 50 percent load change:

5. Ripple and noise: Not exceed 100 mV peak-to-peak.

6. Hold-up time at maximum load: Not less than 16 milliseconds.

7. Continuous duty from 0 to 50 degrees C at rated load.

8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.

9. Output electronically current limited.

10. Over-voltage crowbar shutdown.

11. Output voltage:

a. Rated 24 - 28 Vdc.
b. Adjustable plus or minus 5 percent.
c. Set to provide 24.0 volts.

F. MANUFACTURERS:

1. Sola
2. Allen Bradley
3. PULS

4. Phoenix Contact
5. As shown on the drawings
6. Approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.

3.2 OPERATION AND MAINTENANCE MANUALS

A. Comply with Section 01 77 00 - Project Closeout 01 78 23 - Operations and Maintenance Data and Part 1 of this specification.

3.3 TESTING

A. Power Supplies shall be tested in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer’s recommendations.

B. In addition, the units shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

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SECTION 40 80 00 - COMMISSIONING OF PROCESS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Scope
2. Quality Assurance
3. Submittals
4. Products
5. Testing
6. Functional Checkout

1.2 SCOPE

A. This section specifies the acceptance testing of the process control materials, equipment, and systems. Provide all labor, tools, material, power, and other services necessary to provide the specified tests. All testing described in this section shall be coordinated with the requirements of Section 01 75 16 Start Up Procedures, 26 08 00 Commissioning of Electrical Systems, and 40 61 21 Process Control System Testing.

B. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all test procedures with the requirements of Section 01 75 16. Include the following action items:

1. Develop test plan.

2. Develop record keeping system.

3. Coordinate testing with Vendor package equipment.

4. Coordinate testing with the City's Systems Integrator and Programmer.

C. Testing to include:

1. Pre-Operational - Factory Acceptance Testing (FAT)

2. Component Testing Sequence:

a. Wiring Testing

b. Network and Bus Cable System Inspection and Testing

c. Piping Testing

d. Installation Inspection

e. Instrumentation Calibration

f. Loop Testing

g. Network Testing

3. System (Functional) Testing Sequence:

a. Process Control Strategy/Sequence Testing

b. Control System Closed Loop

c. Functional Checkout

4. Operational Testing:

a. System Acceptance Testing (SAT)

1.3 QUALITY ASSURANCE

A. TESTING MANAGER:

1. The Contractor or Systems Integrator shall appoint a qualified specialist as Testing Manager to manage, coordinate, and supervise the testing work.

2. The Testing Manager requires at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of electrical and instrumentation control systems of equal or greater scope and complexity. PICS Testing Manager to provide a quality assurance program which includes:

a. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the P&ID or drawings if available.

b. Sequential list of the test phases required for each process area and system.

c. Completion status tracking form by process area, system, and test phase.

B. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ANSI/NETA ATS-2009	Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems

C. APPLICATION:

1. Where testing in accordance with this section and other Division 26 and 40 Sections is required, the required tests, including the retesting after the correction of found defects must be complete, and the submittal of final test reports to the Owner for review shall be completed prior to the energizing of material, equipment, or systems.

1.4 SUBMITTALS

A. PROCEDURES: Section 01 33 00

B. SUBMITTAL ITEMS FOR THIS SECTION:

1. Review of Shop Drawings and Brochures shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the noting of some errors, but the overlooking of others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the review of the Shop Drawings and Brochures.

2. Where submitted items deviate from specification requirements, a list of any specification sections that are not being met by the submitted item must be provided. The list is to be organized by specification section and paragraph and shall list the product requirement and in what way submitted item does not comply with the requirement. A detailed written explanation of the reasons for requesting the deviation must also be included.

a. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications.

b. Failure to include a list of the specification section deviations along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Proposed testing procedures including proposed test report forms in accordance with 40 61 21 Process Control System Testing.

   a. Test reports including documentation for all tests performed. Test reports shall be submitted for review prior to the equipment being energized.

   b. Execution plan including schedule.

   c. Test results for a specific piece of equipment as required by the equipment specification shall also be included in the operation and maintenance manual(s).

4. All testing required herein and the test results shall also be submitted and documented as required under Sections 01 75 16, 26 05 00, 40 61 21 and where identified within specific sections.

PART 2 PRODUCTS

2.1 TESTING EQUIPMENT AND INSTRUMENTS

A. The test equipment, instruments and devices used for testing shall be calibrated to test equipment standards with references traceable to the National Institute of Standards and Technology. The test equipment, instruments and devices shall have current calibration stickers indicating date of calibration, deviation from standard, name of calibration laboratory and technician, and date of next recalibration.

2.2 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00 and Section 01 75 16:

1. Defects: Notify the Owner of any material or workmanship found defective within 24 hours of discovery.

2. Short circuit analysis and protective device curves.

3. Test reports: Provide the report required in NETA ATS-2009 paragraph 5.4. Results shall be placed on the forms specified in this Section. Test reports shall also be part of the operation and maintenance manuals.

PART 3 EXECUTION

3.1 TESTING

A. GENERAL

1. Ensure that all electrical system testing performed is in strict conformance with the electrical acceptance tests specified in Section 26 08 00. Contact the Owner 10 days prior to the testing to allow witnessing of all tests.

2. The test measurements shall be recorded on specific forms for the subject test.

3. Testing shall be per ANSI/NETA ATS 2009. Provide testing data sheet for the following:

a. Switchboard assemblies.

b. Transformers – Small Dry-type, air cooled (600 VAC and below, 30 kVA and larger)

c. Cables – Low voltage (600 VAC maximum)

d. Circuit breakers – Low voltage (Insulated Case/Molded Case)

e. Protective Relays

f. Instrument Transformers

g. Metering and Monitoring Equipment

h. Grounding Systems

i. Ground Fault Protection Systems

j. Rotating Machinery

k. Motor Control

l. Variable Speed Drive Systems

m. Outdoor Generator Systems

n. Uninterruptable Power Systems

o. Manual and Automatic Transfer Switches

END OF SECTION

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SECTION 43 21 00 - LIQUID PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.

B. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same Manufacturer.

C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the Owner.

D. Coordinate and utilize all factory testing, installation, start-up, and field-testing services supplied in conjunction with the pumping equipment.

E. All work performed under this Section shall be in accordance with all approved trade practices and Manufacturer's recommendations.

F. Section includes:

1. General design requirements for liquid pumps.
2. Factory testing.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00, Submittal Procedures.

B. Shop Drawings: Provide the following information:

1. Pump name, identification number, and applicable Section number from Project specifications.

2. Performance Data Curves:

a. Showing head, capacity, horsepower demand, net positive suction head (NPSH) required and pump efficiency over the entire operating range of the pump.

b. Pump Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.

c. A family of performance curves at intervals of 100 revolutions per minute (rpm) from minimum speed to maximum speed shall be provided for each pump

equipped with a variable speed drive, and a curve for each speed on two-speed pumps.

3. The limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration, known as the Acceptable Operating Range (AOR), per the Hydraulic Institute.

4. Assembly and Installation Drawings: Including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

C. Complete motor nameplate data as defined by National Electrical Manufacturers' Association (NEMA), Motor Manufacturer and any motor modifications.

D. Manufacturer's warranty.

E. Operation and Maintenance Manual: Containing the required information for each pump section.

F. Spare Parts List: Containing the required information for each pump section.

G. Factory Test Data: Signed, dated, and certified for each pump system which requires factory testing submitted before shipment of equipment.

H. Certifications:

1. Manufacturer's certification of proper installation.
2. Contractor's certification of satisfactory field testing.

I. All pump motor information as required in Division 26.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least 2 years and shall be suitable for the service intended.

B. All materials and equipment shall be new and unused except for the testing specified herein.

C. Compliance with the requirements of the individual pump sections may necessitate modifications to the Manufacturer's standard equipment.

D. All centrifugal pumps shall have a continuously rising performance curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine or encroach on the service factor.

E. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

F. The pumps shall be supplied by a distributor authorized to service them throughout the warranty period and beyond. The distributor shall be located within a 300-mile radius of the site.

G. The pumps shall be warranted by the Manufacturer for a minimum of 1-year from the date of installation.

H. All materials and coatings coming in contact with potable water shall be ANSI/NSF Standard 61 certified.

I. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, suction cans, baseplates, couplings, guards, and other accessories.

J. The complete pump assembly shall be designed and built for continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.

2.2 MATERIALS

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Casings, Class 30, or equal.

2. Stainless steel pump shafts shall be Type 416 or 316.

3. Miscellaneous stainless steel shall be of Type 316, except in a septic environment.

4. Anchor bolts, washers, and nuts supplied by the Contractor for non-corrosive applications shall be galvanized steel in accordance with the requirements of Section 05 50 00, Metal Fabrications. Anchor bolts, washers, and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

2.3 PUMP COMPONENTS, GENERAL

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.

B. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number.

B. Gauges: Provide and install pressure gauges as shown on the Drawings.

1. All pumps (except sample pumps, sump pumps, hot water circulating pumps, and chemical metering pumps) shall be equipped with pressure gauges on the pump discharge.

2. Pump suction lines shall be provided with compound gauges.

3. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

4. Isolation diaphragms shall be provided for all gauges except where pumping potable water.

5. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.

2.5 FACTORY TESTING

A. The following tests shall be conducted on each indicated pump system:

1. Pump Systems: All centrifugal pump systems 50 horsepower (hp) and larger shall be tested at the pump factory in accordance with the American National Standard for Centrifugal Pump Tests (ANSI/HI 1.6) or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by American National Standards Institute (ANSI) and published by the Hydraulic Institute.

2. Tests shall be performed using the complete pump system to be furnished, including the motor.

3. For motors 100 hp and smaller, the Manufacturer's certified test motor shall be acceptable. The following minimum test data shall be submitted:

    a. Hydrostatic test data.

    b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.

    c. Pump curves showing head, flow, brake horsepower (bhp), efficiency and NPSH requirements.

    d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

    e. Pump test data curves showing head, flowrate, bhp, and efficiency. Acceptance level shall be Grade 1E as defined by ANSI/HI 14.6.

4. Factory Witnessed Tests: Factory witnessed testing for this Project not required.

5. Acceptance: In the event of failure of any pump to meet any of the requirements, the Contractor and Pump Manufacturer shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the Owner until found satisfactory.

B. The Pump Manufacturer shall complete a lateral and torsional analysis where required and as specified in the Submittal Article of Section 11 05 00, Common Work Results for Equipment. This analysis shall identify the dry and wet lateral critical and the torsional critical speeds of the pump system and shall be submitted for review as part of the pump submittal.

C. An authorized service representative of the manufacturer shall certify that equipment is designed and constructed such that the natural frequency of the drive train is avoided by a minimum of 25 percent throughout the entire operating range and verify that this performance is achieved after pump installation.

PART 3 EXECUTION

3.1 SERVICES OF PUMP MANUFACTURER

A. As part of this construction contract, the Contractor shall utilize the full value of the Owner-acquired services for start-up and testing services from the Pump Supplier.

B. An authorized service representative of the Manufacturer shall visit the Site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

1. Installation of the equipment.

2. Inspection, checking, and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

5. Requirements are more specifically detailed herein and in individual pump specifications.

C. Instruction of the Owner's Personnel:

1. An authorized training representative of the Manufacturer shall visit the Site to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

2. Instruction shall be specific to the models of equipment provided.

3. The Pump Manufacturer's representative shall have at least 2 years' experience in training.

4. Training shall be scheduled a minimum of 3 weeks in advance of the first session.

5. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

6. The training materials shall remain with the trainees.

7. The Owner may videotape the training for later use with the Owner's personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment:

1. All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects.

2. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.

3. Equipment shall be secure in position and neat in appearance.

C. Lubricants: Provide the necessary oil and grease for initial operation.

3.3 FIELD TESTS

A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.

C. The following field testing shall be conducted:

1. Startup, check, and operate the pump system over its entire speed range. Where vibration analysis and measurement are required, it shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Determine motor bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test unless insufficient liquid volume is available.

4. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.

5. Field vibration readings shall be conducted by the manufacture's representative paid for by the Contractor, with readings taken at the following positions with the average not exceeding the current Hydraulic Institutes standards for the type of pump installed.

a. Measurements shall be taken at the locations as specified in the current Hydraulic Institute standards for the type of pump installed.

6. Provide written proof of vibration readings and provide test data.

D. Field testing will be witnessed by the Engineer. The Contractor shall furnish 3 days' advance notice of field testing.

E. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

F. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

G. Contractor shall bear all costs of field tests, including additional services of the Manufacturer's representative required beyond those specified.

END OF SECTION

SECTION 43 21 27 - VERTICAL TURBINE PUMPS, CAN TYPE, OPEN LINESHAFT

PART 1 GENERAL

1.1 SUMMARY

A. Work covered in this Section includes furnishing, installing, start-up and operation training for vertical turbine pumps of the can type with open lineshaft.

B. Like items of equipment specified herein shall be the end product of one manufacturer.

C. Electrical controls and motor design requirements are specified in this section and the electrical section of these specifications.

D. The pump supplier shall be responsible for coordinating the pump requirements with the pump drive manufacturer and shall be responsible for the overall pump and drive requirements.

1.2 SUBMITTALS

Submittals during construction shall be made in accordance with Section 01 33 00, Submittal Procedures and Section 43 21 00, Liquid Pumps.

1.3 REFERENCES

Pumps shall meet the requirements of the latest version of ANSI/AWWA E-103, Horizontal and Vertical Line Shaft Pumps, the Hydraulic Institute Standards (ASNI/HI 2.1-2.2-2.3), and ANSI/HI 9.8 Rotodynamic Pumps for Pump Intake Design, except where modified herein.

1.4 PUMP ANALYSIS AND VIBRATION TESTING

A. Pump vendor shall provide testing per Section 43 21 00, Liquid Pumps.

B. Field vibration measurements during field testing of each pump-motor unit shall be provided per Section 43 21 00, Liquid Pumps.

1. The specialist or their assigned representative who shall similarly be experienced in this type of work and who shall be approved by the Owner shall visit the project site during startup and testing of the equipment to analyze and measure the amount of pump vibration and make a written recommendation for keeping the vibration at a safe limit.

2. If vibration results exceed the specified limits as identified in Section 43 21 00, Contractor and Pump Supplier shall make corrections until the vibration limits are met. This could include balancing of the pumps, resurfacing of pump mounting flanges or base plate, or other approved corrective measures to meet the vibration limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable pump manufactures American Turbine (National Pump Co.), or approved equal.

2.2 PERFORMANCE REQURIMENTS

A. Operating Conditions all Pumps:

Duty	Continuous
Drive	Variable Frequency Drive
Ambient Environment	Indoor
Ambient Temperature	33° - 104° F
Fluid Service	Potable Water
Fluid Temperature	45° - 75° F
Fluid pH Range	6.0 to 8.5
Fluid Specific Gravity	1.0
Fluid Viscosity (absolute) (centipoises at 60° F)	1.12
Pump Station Floor Elevation	Approx. 1283.5 ft

B. Performance Requirements at Full Pump Speed:

Pump 1 & 2 Current			
	Duty Point 1 (Primary Duty Point)	Duty Point 2	Duty Point 2
Flow Rate (gpm)	625	300	725
Total Dynamic Head, min (ft)	152	195	123
Minimum Overall Pump Efficiency (%):	84		
Maximum Pump Speed (rpm)	1,800		
Motor Size (hp)	50		

Pump 1 & 2 Future			
	Duty Point 1 (Primary Duty Point)	Duty Point 2	Duty Point 2
Flow Rate (gpm)	1000	600	1150
Total Dynamic Head, min (ft)	152	195	123
Minimum Overall Pump Efficiency (%):	80		
Maximum Pump Speed (rpm)	1,800		
Motor Size (hp)	30		
Pump 3 and 4			
	Duty Point 1 (Primary Duty Point)	Duty Point 2	Duty Point 2
Flow Rate (gpm)	1590	990	2250
Total Dynamic Head, min (ft)	195	234	122
Minimum Overall Pump Efficiency (%):	83		
Maximum Pump Speed (rpm)	1,800		
Motor Size (hp)	100		

1. The head-capacity curve shall exhibit a uniformly rising characteristic from free discharge to shutoff. The pump motor shall be non-overloading throughout the entire pump curve.

2. All flow capacity and head duty points shall be within the Preferred Operating Range (POR) of 70% to 120% of the Best Efficiency Point (BEP). Pumps shall only operate within the POR.

3. Refer to contract drawings for connection sizes and other project specific dimensional requirements.

4. Pump 1 and 2 pump cans and discharge head shall be sized for the future conditions.

2.3 PUMP CONSTRUCTION

A. Pump bowls shall be cast-iron, epoxy lined and coated per AWWA C210 with a two component, self-priming coating applied in a two coat process, over a sandblasted surface. All wetted parts shall be coated with Tnemec Pota Pox, or Scotchkote 134 with a total thickness of 12 mils.

B. The impellers shall be Type 316 stainless steel and shall be statically and dynamically balanced. They shall be securely fastened to the shaft with tapered lock collets, threaded lock collets or double keys. The impellers shall be adjustable vertically by external means at the driver location.

C. Replaceable impeller and pump bowl wear rings shall be provided. Impeller and pump bowls wear rings shall be ASTM B62 UNS C83600 bronze for pumps with bronze impellers. For pumps with stainless steel impellers, Type 316 stainless steel wear rings shall be provided on the impellers with bronze for the pump bowls.

D. The bowl shaft shall be stainless steel, Type 410, 416, or 316.

E. The suction bell shall be cast-iron with a bottom bearing and streamlined ribs. Lining and coating shall be the same as the pump bowls.

F. The column pipe shall be not less than Schedule 40 steel pipe. Pipe sections shall not exceed 10 feet in length. The column pipe shall be epoxy lined and coated with the same coating as the pump bowls.

G. The line shaft and couplings shall be Type 416 stainless and sized such that the natural frequency of the shaft is avoided by a minimum 25 percent throughout the entire operating range. Line shaft sections shall not exceed 10 feet in length.

H. Line shaft shall be product lubricated.

I. The shaft seal shall be a mechanical type seal and equipped with non-clogging, single coil springs and non-sliding, internal, secondary elasteners. Metal parts shall be Type 316 stainless steel alloy 20, or Hastelloy B or C. Sealing materials shall be resin impregnated carbon for primary ring and silicon carbide for mating ring. O-ring material shall be flouro elastemer. Seal shall be John Crane type 5610, or approved equal.

J. The discharge head shall be fabricated steel. Fabricated steel discharge head shall be reinforced to withstand pipe thrust and the entire weight of the pump and driver. Discharge head shall be lined and coated with an NSF 61 coating system that matches the pump bowls and shall include flange and base plate. Forged steel half-couplings for air valve, pressure switch and drain connections shall be a minimum of 1 1/4-inch and 3000 lbs.

K. The motor shaft coupling shall be a 4-piece, heavy-duty adjustable spacer coupling, to allow for mechanical seal removal, with machined registered fit per pump manufacturer and complying with ANSI/AWWA E-103 and ANSI/HI 2.1 through 2.5 specifications.

L. The bottom bearing shall be a close tolerance sleeve type conforming to ANSI/AWWA E-103 and ANSI/HI 2.1 through 2.5 specifications with a length minimum of 2 1/2 times shaft diameter. Suction case shall be permanently grease lubricated with non-soluble grease.

M. The bowl and suction case bearings shall be of the bronze sleeve type.

2.4 SUCTION BARREL FOR CAN TYPE PUMPS

A. The suction barrels (cans) shall be supplied by the pump manufacturer and shall be fabricated steel, minimum 3/8-inch thick, lined with NSF 61 listed coating system that matches the pump bowls, with an extra-heavy carbon steel mounting plate, drilled and tapped to match the discharge head. Suction barrel shall come equipped with flow vanes configured in accordance with HI and Pump Manufacturer requirements.

2.5 MOTORS

Each pump shall be provided with a vertically mounted electric motor that conforms to the following requirements and the specifications in Division 26 05 86, Premium Efficiency Vertical Motors. The brake horsepower required by the driven equipment anywhere on the pump curve shall not exceed the rated nameplate horsepower of the motor. The ratings indicated are minimums. Motors shall be designed to accept the total, unbalanced thrusts imposed by the pump.

2.6 PUMP CONTROLS

For controls see Specifications within Division 40 .

2.7 SPARE PARTS:

The pumps shall be provided with the following spare parts for each pump:

A. One mechanical seal.

PART 3 EXECUTION

3.1 PUMP BARREL INSTALLATION

A. Install pump barrels beneath the existing pump station floor as shown on the drawings. Install the pump barrel with the pump mounting flange horizontal. The pump barrel shall be installed so the pump mounting flange is level within 0.002 inch per foot when measured along any horizontal axis, and shall not exceed 0.005 inch across the plate of the can. These values must be verified in the presence of the Owner's Representative.

B. Contractor shall provide on-site machining of the pump barrel flange if the installation is not as level as stated above at no additional cost to the Owner. Repair any damaged coatings by field touch-up using a manufacturer approved touch up coating system and follow manufacturer requirements for touch-up.

C. Contractor shall provide written acceptance from the pump manufacturer that the pump barrel flanges have been checked for alignment and are certified as being within

the required manufacturer's tolerance and as stated herein, prior to mounting the discharge heads on the pump barrels.

3.2 SERVICES OF MANUFACTURER

A. Installation -- The service representative of the manufacturer shall be continuously present at the site to supervise the assembly and installation of the pumps.

B. A factory Certified Representative of the pump manufacture shall be provided to conduct all testing and training as specified in 43 21 00 Liquid Pumps. Coordinate with Engineer and Owner.

C. Field Vibration: Test for acceptable vibration will be made at no additional cost to the owner in the field on each pump system. All field tests will be running tests with the pump pumping product for which it is intended and each pump system will be tested separately with no other pump running. All tests will be done in the presence of the design engineer. Amplitude as used in this specification will mean peak to peak displacement, the requirements for testing for acceptable vibration will be the measurement of this peak to peak displacement at 5 separate points on the motor and five separate points on the discharge head.

D. Field Harmonics: During star-up the pump manufacture will perform a Reed Critical Frequency (RCF) analysis commonly referred to as a "bump test". The bump test will be done through the full operating range of the pump speed, from min speed to max speed. If there are any reflections of harmonics through the operating range of the pump it will be the pump manufactures responsibility to either correct the problem or inform the owner of the speeds that will need to be avoided through the Variable Frequency Drive Settings. A full report of these findings will be provided to the owner before final acceptance of the equipment.

E. The ENGINEER may require that the inspection, startup, and field adjustment services above be furnished in separate trips.

F. The Contractor shall weigh the motor and pump assembly and stamp the weight on the housing in a location readily visible after installation.

END OF SECTION

DRAWINGS

SUPPLEMENTARY INFORMATION

Geotechnical Engineering Evaluation

Proposed East Side Booster Station
Pendleton, Oregon

for
Consor

January 19, 2023

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Evaluation

Proposed East Side Booster Station
Pendleton, Oregon

for
Consor

January 19, 2023

GeoEngineers

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Spokane, Washington 99202
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Geotechnical Engineering Evaluation

Proposed East Side Booster Station
Pendleton, Oregon

File No. 8946-003-06

January 19, 2023

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LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

This report presents the results of GeoEngineers, Inc.'s (GeoEngineers) geotechnical engineering evaluation during design for the proposed East Side Booster Station (Booster Station) located east of Goad Road in Pendleton, Oregon. The approximate location of the project site is shown in the Vicinity Map, Figure 1.

We understand the City of Pendleton (City) intends to build a booster pump station for the City's water system at the site. The proposed Booster Station will have a footprint of about 20 feet by 30 feet. Additional site improvements will include a gravel access road, paved parking area and a stormwater pond. The approximate locations of the proposed improvements relative to existing site features are shown in the Site Plan, Figure 2.

Foundation loads were not available at the time we prepared this report. However, we anticipate that loads will be light, less than about 3 kips per linear foot for exterior wall loads and less than about 50 kips for interior column or equipment loads. Based on review of the preliminary grading plans, cuts in the range of less than 1 foot to about 2 feet and fills of about 1 foot will be required to establish finished floor grade for the proposed Booster Station. Fills in the range of about 1 to 10 feet also will be required to establish final exterior site grades for the parking and access areas.

2.0 SCOPE OF SERVICES

The purpose of our services was to provide geotechnical engineering recommendations for the design and construction of the proposed development. Our recommendations are based on subsurface exploration, laboratory testing and engineering analysis. We performed our services in accordance with our proposal dated October 10, 2022. Authorization of our services via electronic communication was provided on October 11, 2022. Our specific scope of geotechnical services included:

1. Observing excavation of test pits completed by City personnel.
2. Conducting two in-situ infiltration tests within excavations located within the proposed stormwater pond area.
3. Conducting geotechnical laboratory testing of select soil samples.
4. Providing recommendations for design and construction of the proposed project, including:
    a. An evaluation of the stability of existing and proposed slopes at the site.
    b. Temporary and permanent slope inclinations.
    c. Site preparation and fill placement.
    d. Potential to reuse excavated site soils as structural fill and criteria for imported structural fill.
    e. Geotechnical criteria for design of shallow spread foundations to support the proposed Booster Station building, including allowable bearing pressure, minimum width and depth criteria, coefficient of sliding and passive earth pressure to resist lateral loads, and recommendations for mitigation of unsuitable soil that might be present at foundation grade.
    f. Seismic design criteria.

g. Infiltration rates for design of the proposed stormwater pond.

h. Pavement thickness for the proposed parking/access area.

3.0 SITE SURFACE CONDITIONS

The project site is situated on gently sloping terrain inclined at an overall slope of about 4H:1V (horizontal to vertical) to 6H:1V, sloping down towards the north. A steeper area is located to the south of the site, inclined at about 2H:1V with a vertical relief of about 10 to 15 feet. The site is vegetated with grass and weeds. Goad Road and an adjacent drainage ditch bounds the site to the west and north. Undeveloped and agricultural fields are located to the south and east. General site features are shown in Figure 2.

4.0 SITE SUBSURFACE CONDITIONS

4.1. Literature Review

4.1.1. Geology

The Oregon Department of Geology and Mineral Industries (DOMAGI) maps the site as the McKay Formation. This geologic unit consists of conglomerate with sandstone and siltstone interbeds. Conglomerate is a sedimentary rock consisting predominantly of rounded to subrounded gravel with variable silt, sand, cobble and boulder content that has been cemented or welded into a rock mass. This geologic unit overlies or is interbedded with basalt flows of the Saddle Mountains member of the Columbia River Basalt Group. The McKay Formation is often mantled by relatively thin layers of wind-blown silt (loess) deposits.

4.1.2. Soil Survey Map

We reviewed the Natural Resource Conservation Service (NRCS) Web Soil Survey, which provides general information on soil within the upper 5 feet of a site. The NRCS maps surficial soil at the site as Walla Walla silt loam, 12 to 25 percent slopes. The typical profile for Walla Walla silt loam soil consists of silt (loess) to depths of at least 5 feet. The NRCS indicates this soil typically exhibits high potential for frost heave, moderate potential for corrosion of uncoated steel and low potential for corrosion of concrete.

4.2. Field Activities

We explored subsurface conditions at the site on November 3, 2022 by observing excavation of nine test pits (TP-11 through TP-19) at the approximate locations shown in Figure 2. Note that test pits TP-1 through TP-10 were excavated on the same day for a nearby project (Connector Road Water Line) and are not included in this report. The test pits were excavated to depths in the range of about 2 to 12 feet below ground surface (bgs) using a rubber-tired backhoe owned and operated by the City.

Representative soil samples from the test pits were returned to our laboratory for examination. Detailed descriptions of our site exploration and laboratory testing programs along with exploration logs are presented in Appendix A.

We conducted two in-situ single ring infiltration tests (IT-1 and IT-2) at the locations of test pits TP-17 and TP-19, respectively within the proposed stormwater pond area. The test pits were each excavated to a depth of about 2 feet below existing site grade (the approximate proposed bottom of pond elevation). Following

excavation, a 12-inch-diameter steel ring was pushed about 11 to 12 inches into the soil at the bottom of the excavation using the backhoe bucket. Water was then introduced into the steel ring to a height of about 6 inches above the soil. A constant head test was performed by allowing the water level to drop over a 10-minute period. After each 10-minute period, the water level was measured, and the ring was refilled to the starting level. After 2 hours, a falling head test was conducted, which consisted of measuring the water level within the ring over an additional 25 to 215 minutes. Results of the infiltration tests are presented in Appendix B.

4.3. Subsurface Conditions

In our opinion, subsurface conditions encountered in our explorations are generally consistent with the published geologic and soil survey literature. However, we did encounter ash-like silt deposits in several test pits that appeared to be inconsistent with conditions in other test pits. For the purposes of this report, we characterized soil and rock into four general units: (1) topsoil; (2) ash; (3) silt; and (4) conglomerate.

4.3.1. Topsoil

At most of the test pit locations, we encountered about 4 to 6 inches of topsoil consisting of dark brown very soft silt with organic matter. For the purposes of this report, we generally define topsoil as a fine-grained soil with an appreciable amount (generally more than about 15 percent by volume) of organic matter based on visual examination. It is unsuitable for direct support of the proposed improvements. However, the organic content, and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and for agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report, and our logs and descriptions should not be used as a basis for concluding that topsoil from the subject site is suitable for use in landscaping or for agricultural purposes, nor for estimating the volume of topsoil that could be available for such purposes.

4.3.2. Ash

At the locations of test pits TP-12, TP-13 and TP-14, we encountered white ash-like silt, which extended to depths in the range of about 3 to 9 feet bgs. The ash was generally described as having very low density. We characterized the ash as having very low strength, high compressibility, low permeability and high susceptibility to changes in moisture content. It is possible that the ash is uncontrolled fill, as it was not observed in the other test pits.

4.3.3. Silt

At the locations of each of the test pits, below the ash or topsoil, where present, we encountered soft to stiff brown silt. This soil unit extended to the depths explored at most of the test pits. We characterized the silt as having low strength, moderate compressibility, low permeability and high susceptibility to changes in moisture content.

4.3.4. Conglomerate

At the locations of test pits TP-13 and TP-15, we encountered conglomerate (cemented gravel) at depths of about 8 feet and 11 feet bgs, respectively. We characterized the conglomerate unit as having high strength, low compressibility, very low permeability and low susceptibility to changes in moisture content.

4.4. Groundwater Conditions

We did not encounter groundwater within the explorations. Based on the review of available well reports from the Oregon Water Resources Department, we anticipate the regional groundwater table is many tens of feet below site grade.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our geotechnical engineering evaluation, we believe the project can be constructed as envisioned, provided recommendations in this report are followed during design and construction. The following presents a brief description of geotechnical considerations for this project:

- We encountered weak, compressible silt soil at the locations of test pits excavated near the proposed building that we characterize as possible ash fill. The presence of compressible soil below the proposed building could result in unacceptably large total and differential settlement of the building and associated equipment. Therefore, we recommend the ash-like silt be removed from below the proposed building footprint. In order to provide uniform bearing conditions, we recommend conducting a mass excavation of the entire building footprint to expose stiff silt, conglomerate or to a depth of 9 feet below site grade, whichever occurs first. The bottom of the excavation should extend laterally at least 10 feet beyond the building perimeter. The excavation should be backfilled with suitable imported structural fill.
- We recommend pavement and access areas be supported by at least 2 feet of imported structural fill.
- Within access and pavement areas, we recommend placing a geotextile stabilization fabric between undisturbed site soil exposed at working subgrade following initial stripping and excavation activities and the overlying imported structural fill.
- We understand excavated material consisting of conglomerate from the nearby Connector Road Water Line project is intended for use at this project site for fill. In our opinion, the excavated conglomerate from the Connector Road Water Line site should be suitable for use at this project site as general imported structural fill. Some additional processing of the excavated conglomerate might be required depending on the size and condition of the excavated material. Additional processing could include crushing or pulverizing larger pieces of cemented material, mixing with other sand or gravel to create a reasonably well-graded mixture, or moisture-conditioning to get the excavated material to within about 3 percentage points of optimum moisture content.
- Given the relatively gentle site slopes, slope instability should not be an issue. However, site soil is highly prone to erosion. Appropriate temporary and permanent erosion control measures should be implemented to reduce the potential for erosion and sloughing of site slopes. Existing site slopes inclined steeper than 5H:1V should be benched in preparation of fill placement.
- Conventional earthmoving equipment should be adequate for initial stripping, excavation and filling activities.
- Given the moisture sensitivity of the site soil, site preparation and earthwork activities could be difficult, particularly if earthwork occurs outside of the ideal earthwork construction season in eastern Oregon (approximately June through September). When the moisture content of the silt soil is above optimum, the soil could become muddy and unstable when subjected to disturbance and construction traffic.

We recommend earthwork activities take place during the normally warmer and drier months of the year, if feasible.

These and other considerations are discussed in the following sections of this report. This report should be read in its entirety to fully understand geotechnical design and construction considerations and recommendations.

5.1. Seismic Considerations

5.1.1. Faults

The nearest mapped quaternary fault is a portion of the Hite Fault system, mapped about 6 miles east of the project site. Based on the distance from the site to the fault, the risk of ground rupture is low in our opinion.

5.1.2. Seismic Parameters

Based on the results of our explorations and review of available information including water well reports in the site vicinity available on the Oregon Department of Water Resources on-line well database and geologic mapping, it is our opinion that the site classifies as a Site Class C. We have provided seismic design parameters in accordance with the 2018 International Building Code (IBC) as shown in Table 1. Note that the 2018 IBC references the 2016 Minimum Design Loads for Buildings and Other Structures (American Society of Civil Engineers [ASCE] 7-16).

TABLE 1. MAPPED 2015 IBC SEISMIC DESIGN PARAMETERS

Seismic Design Parameters	Recommended Parameters
Site Class	C
Mapped Spectral Response Acceleration at Short Periods (S_s)	0.363
Mapped Spectral Response Acceleration at 1 Second Period (S_1)	0.136
Site Amplification Factor at 0.2 Second Period (F_a)	1.3
Site Amplification Factor at 1 Second Period (F_v)	1.5
Design Spectral Acceleration at 0.2 Second Period (S_{DS})	0.315
Design Spectral Acceleration at 1 Second Period (S_{D1})	0.136

Note:
Parameters developed based on Latitude 45.66771759 and Longitude -118.7562027 using the ATC Hazards online tool.

Note that a site-specific seismic evaluation is beyond our scope of services for this project. We should be contacted to provide additional services if a site-specific seismic evaluation is required.

5.2. Foundation Support

5.2.1. Minimum Width and Embedment

Individual (column) and continuous (wall) footings should be designed with minimum dimensions of 24 inches and 18 inches, respectively. Exterior footings should be embedded at least 24 inches below exterior finished grade for frost protection. Interior footings within heated areas should be embedded at least 12 inches below finished floor grades to provide sufficient bearing resistance.

5.2.2. Allowable Bearing Pressures

Individual and continuous footings should bear on soil prepared as recommended in the "Site Preparation and Earthwork" and "Structural Fill" sections of this report.

Individual (columns) and continuous (wall) footings may be designed using an allowable bearing pressure of 2,500 pounds per square foot (psf). The weight of overlying fill may be neglected when estimating foundation loads. The allowable bearing pressure include a safety factor of about 3 and may be increased by one-third for short-term live loads such as wind and seismic events.

5.2.3. Settlement

Based on the maximum foundation loads of less than 3 kips per lineal foot for wall loads and 50 kips for column or point loads, we estimate that total foundation settlement (between columns, or along approximately 20 feet of continuous foundations) should be less than about 1 inch. Differential settlement should be less than about ½ inch. If foundation loads exceed the assumed amount provided at the beginning of this report, it will be necessary for us to re-evaluate foundation settlement for the proposed building.

Settlement should occur relatively rapidly, essentially as loads are applied. On this basis, post-construction total and differential settlement should be small, and will be a function of the magnitude of live load. Loose soil, including ash-like silt and other fill soil not removed from footing excavations, or disturbance of soil at foundation grade during construction could result in larger settlements than estimated.

5.2.4. Lateral Resistance

The ability of shallow foundations to resist lateral foundation loads is a function of the frictional resistance against the foundation base and the passive resistance, which can develop on the face of below-grade elements of the structure as those elements move horizontally into the soil. For foundation grade prepared as recommended herein, the allowable frictional resistance may be computed using a coefficient of friction of 0.45. This value should be applied to vertical dead load forces for the contact between the bottom of the footing and supporting material.

The allowable passive resistance on the face of footings may be computed using an equivalent fluid density of 250 pounds per cubic foot (pcf), triangular distribution, for on-site soil or imported structural fill. This is based on the condition that backfill placed against embedded elements is compacted to at least 95 percent of maximum dry density (MDD). Note that lateral movement on the order of about 0.02D will be required to mobilize the design passive resistance (where D is the height of the foundation element). For example, for 2-foot-thick footings, the lateral deformation required to develop the allowable passive resistance is about ½ inch.

Both the frictional coefficient value and the equivalent fluid density value presented above include a safety factor of about 1.5.

5.3. Floor Slab Support

For a floor slab supported by structural fill overlying suitable on-site soil as recommended in the "Site Preparation and Earthwork" section of this report, we recommend the building floor slab be designed using a modulus of vertical subgrade reaction (k) of 300 pounds per cubic inch (pci). Please note that this value

is valid for floor slabs designed to resist point loads. The modulus of vertical subgrade reaction varies as a function of the size of the loaded area. The equation below may be used to estimate the modulus of vertical subgrade reaction for slab loads of various widths.

$$K = K_{S1} \frac{(B+1)^2}{4B^2}$$

Where:

- K is the modulus of vertical subgrade reaction for loaded area of width B (pci);
- K_{S1} is the modulus of vertical subgrade reaction for a point load (300 pci); and
- B is the lateral dimension of the loaded area of the slab (in feet).

The structural engineer should design the thickness and required reinforcement of the floor slab based on the anticipated structural floor loads.

We recommend the floor slab be underlain by a minimum 4-inch-thick layer of crushed aggregate base underlain by imported structural fill.

5.4. Pavements

We recommend pavement materials at the site conform to applicable sections of the current Oregon Department of Transportation (ODOT) Standard Specifications or City of Pendleton Standard Specifications, as applicable.

Determining suitable thicknesses for pavement sections should consider the following:

- Minimum thickness required to support the estimated traffic loads based on the characteristics of the supporting subgrade soil (structural design).
- Thickness required to resist frost heave (if the site is susceptible to frost heave).
- Constructability. A thicker subbase section or use of high strength geotextile and/or geogrid might be necessary in order to construct a suitable working pad during construction if the subgrade soil is soft and unable to support construction traffic during earthwork.

We assume that vehicular traffic will consist predominantly of light passenger cars and pickups, and occasional heavy trucks. We should be contacted to re-evaluate our recommended pavement thicknesses if the pavement could be subjected to uncommon vehicular loads.

Based on the preliminary grading plans, most of the pavement area will be supported by at least 2 feet of fill. Given the relatively soft nature of the on-site soil, we recommend overexcavating existing site soil, where necessary, in order to provide at least 2 feet of structural fill below all pavement and access road areas. Our recommended pavement section is presented in Table 2.

TABLE 2. HOT-MIX ASPHALT (HMA) PAVEMENT THICKNESS RECOMMENDATIONS

HMA Thickness (inches)	Crushed Aggregate Base Thickness (inches)	General Imported Structural Fill Thickness (inches)
3	4	20

Note in Section 5.6.4 of this report that because of the anticipated presence of soft, moisture-sensitive soil at working subgrade following initial stripping and excavation activities, we recommend placing a geotextile fabric meeting Oregon DOT criteria for "Embankment Geotextile" on top of undisturbed site soil supporting pavement and access areas before placing structural fill.

5.5. Site Drainage

The following sections provide information on temporary drainage and stormwater considerations.

5.5.1. Temporary Drainage

Some local ponding of water from precipitation could occur in excavations during construction. Site excavations should be provided with appropriate ditches and sumps to keep exposed areas as dry as possible.

5.5.2. Stormwater Considerations

We recommend that all surfaces be sloped to drain away from proposed structures. Pavement surfaces and open spaces should be sloped such that surface runoff is collected and routed to suitable discharge points. Roof drains should be tight lined to suitable discharge points located at least 15 feet from building perimeters. Table 3 presents the results of our infiltration tests.

TABLE 3. INFILTRATION TEST SUMMARY

Test No.	Test Pit No.	Test Depth (ft)	Soil	Unfactored Infiltration Rate (in/hr)
IT-1	TP-17	2	Silt	1
IT-2	TP-19	2	Silt	3

Note:
in/hr = inches per hour

Typically, a safety factor of 2 to 4 is applied to unfactored rates to determine a long-term design infiltration rate based on field data. Selecting a safety factor for a specific site usually includes consideration for site variability, maintenance (or lack thereof), cost and potential consequences if the long-term infiltration rate is less than the design rate. Preliminarily, we recommend using a safety factor of 3, which would result in a design infiltration rate of 0.67 in/hr. The design engineer should adjust the safety factor and design infiltration as necessary, based on their knowledge of the above factors. In our opinion, site variability does not warrant an especially aggressive or conservative safety factor.

5.6. Site Preparation and Earthwork

We anticipate site preparation and earthwork operations could include: (1) clearing, stripping and grubbing; (2) site grading to establish final subgrade elevations for exterior pavement, hardscape and stormwater facilities; (3) site grading to establish foundation grade for interior footings and subgrade for slab-on-grade

floors; and (4) trenching and installation of underground utilities. Our specific recommendations for site preparation and earthwork are presented in the following sections.

5.6.1. Initial Site Preparation

We recommend all proposed pavement, hardscape and other improvement areas be stripped of topsoil and deleterious and organic matter. Based on our explorations, we estimate the stripping depth to remove topsoil within existing swale and undeveloped areas could be in the range of about 6 inches. Greater stripping depths might be encountered during construction in other areas of the site not explored.

5.6.2. General Grading and Excavation

In our opinion, conventional earthmoving equipment such as excavators, backhoes and dozers should be adequate for initial stripping, excavation and filling activities.

Existing site slopes 5H:1V or steeper should be benched in preparation of fill placement. Benches should penetrate the existing slope at least 5 feet and should not be more than 5 feet tall.

As stated previously, the existing site soil is highly moisture sensitive and will be difficult to work or compact if moisture contents are greater or less than the optimum moisture content by about 3 percentage points. Accordingly, earthwork using these moisture sensitive soils during or after periods of wet weather should be avoided, if possible. If earthwork activities cause excessive subgrade disturbance, replacement with structural fill might be necessary. Additionally, the natural moisture content of these soil units could be more than about 3 percent above optimum at the time earthwork is performed. Therefore, proper moisture conditioning might be required, such as scarifying and aerating, to achieve suitable moisture contents before the soil can be reused on site.

Disturbance to a greater depth also should be expected when site preparation work is conducted during periods of wet weather, or if the soil moisture content is near saturation. Accordingly, if earthwork activities are performed during wet weather or outside of the typical warm weather construction window in eastern Oregon, we recommend that the project specifications and budget include provisions for removal of unsuitable material and importing and compacting additional structural fill.

5.6.3. Excavations for Subgrade and Foundation Grade

At the time of our explorations, soil across the site consisted of soft, highly moisture sensitive silt soil and possible fill. Therefore, we recommend the following considerations for site preparation:

- Very soft ash silt should be removed from below the proposed building footprint. Therefore, we recommend overexcavating to stiff undisturbed silt, conglomerate or a to depth of 9 feet below existing site grade within the proposed building footprint. The bottom of the excavation should extend at least 10 feet laterally beyond the building perimeter. The excavation should be backfilled with properly placed and compacted imported general structural fill to re-establish foundation grade and floor slab subgrade. The backfilled area outside of the building footprint should be capped with pavement or at least 6 inches of low-permeability soil within non-settlement sensitive areas to reduce the potential for migration of surface water into the backfill zone. On-site silt soil should be suitable for reuse as low-permeability soil.

- Access and parking areas should be supported by at least 2 feet of imported structural fill, overlying undisturbed site soil.

5.6.4. Subgrade Preparation

Based on the subsurface conditions observed in the test pits, we anticipate that soft silt soil will be present at working subgrade following initial stripping and excavation activities. We further anticipate that attempting to compact the soil using conventional compaction equipment or proof-rolling could lead to more soil disturbance without successfully improving the strength and stiffness of the soil. Therefore, we recommend the following:

- Within areas not directly supporting access roads or pavement, place structural fill directly on top of undisturbed site soil. The first two lifts of structural fill should be maximum 6-inch-thick lifts and should be compacted using static methods. Subsequent lifts may be compacted using vibratory methods.
- Within areas supporting access roads or pavement, place a geotextile fabric on top of the on-site silt soil exposed at working subgrade before placing structural fill. The geotextile should meet criteria in the Oregon DOT Standard Specifications, section 0230.10B for "Embankment Geotextile." Geotextile installation should be in accordance with section 00350.41 of the Oregon DOT Standard Specifications.

A representative of GeoEngineers should evaluate soil conditions at working subgrade before placing structural fill.

5.7. Structural Fill

Soil used as fill to support foundations, slab-on-grade floors, access road and paved areas is classified as structural fill for the purposes of this report. Structural fill material requirements vary, depending upon its use as described below. Structural fill should be free of debris, organic material, frozen soil and particles larger than 4 inches in maximum dimension.

5.7.1. Use of On-site Soil as Structural Fill

In our opinion, the on-site soil is not suitable for reuse as structural fill below buildings, access or paved areas. Excavated on-site soil may be used as fill within non-settlement sensitive areas, if approved by the City or properly disposed of off-site.

5.7.2. Imported Structural Fill

Imported structural fill, where required, should meet the following criteria:

- General Structural Fill -- Imported general structural fill placed below foundations, floor slabs, and pavements (as general structural fill or subbase) should consist of a well-graded sand or sand and gravel mixture with less than about 10 percent fines. As indicated previously, conglomerate excavated from the nearby Connector Road Water Line project should be suitable for use on this project as general structural fill.
- Imported structural fill used as base course for pavements should consist of ¾-inch-minus crushed aggregate meeting applicable City of Pendleton or Oregon DOT criteria.

5.7.3. Fill Placement and Compaction Criteria

Structural fill should be placed in loose lifts not exceeding 8 inches in thickness (or a thickness compatible with the compaction equipment used, not to exceed 12 inches) and mechanically compacted to a firm condition. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. We recommend structural fill be compacted to the following criteria based on the ASTM International (ASTM) D 1557 laboratory test procedure.

- Soil used as structural fill placed within the proposed building footprint, regardless of depth below floor subgrade or foundation grade, should be compacted to at least 92 percent of the previously mentioned MDD.
- Structural fill in roadway access and parking areas, including utility trench backfill, should be compacted to at least 90 percent of the MDD, except the upper 2 feet of fill below final subgrade should be compacted to a minimum 95 percent of the MDD.

Non-structural fill, such as fill placed in landscaped areas, should be compacted to at least 85 percent of the MDD, with the exception that compaction should not exceed 85 percent for fill placed within stormwater swales. In areas intended for future development, a higher degree of compaction should be considered to reduce the settlement potential of the fill soil. Structural fill that consists of material too granular to test should be compacted using method or performance specifications, as determined by the Geotechnical Engineer-of-Record.

We recommend a representative of GeoEngineers be on site during earthwork operations to observe site preparation and structural fill placement. Soil conditions should be evaluated by in-place density tests, visual evaluation, probing and proof-rolling of the structural fill and recompacted on-site soil, as it is prepared, to check for compliance with contract documents and recommendations in this report.

5.7.1. Cut and Fill Slopes

5.7.1.1. Temporary Slopes

In our opinion, excavations in the on-site soil are highly susceptible to sloughing and caving. Excavations deeper than 4 feet should be shored or sloped at stable inclinations if workers are required to enter such excavations. Shoring for excavations must conform to applicable provisions of the Oregon Occupational Safety and Health Standards, Division 3, Subdivision P "Excavations" for excavation, trenching and shoring.

In our opinion, site soil classifies as Type C for excavation purposes. The maximum allowable temporary slope for Type C soil is 1.5H:1V for simple excavations less than 20 feet deep located above the groundwater table or seepage zone.

Temporary cut slope guidance assumes that all surface loads are kept a minimum distance of at least one-half the depth of the cut away from the top of the slope. Flatter slopes will be necessary if surface loads are imposed above the cuts a distance equal to or less than one-half the depth of the cut. It is the contractor's responsibility to monitor and adjust the inclination of temporary excavated slopes and assure site safety during the proposed construction.

Alternatively, temporary shoring should be installed if space constraints limit the depth and/or inclination of cut slopes. Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under state of Oregon regulations, as applicable.

While this report describes certain approaches to excavation, the contract documents should specify that the contractor is responsible for selecting excavation methods, monitoring the excavations for safety, reducing temporary slope inclinations to improve stability and providing shoring, as required, to protect personnel.

5.7.1.2. Permanent Slopes

We conducted a slope stability evaluation of the existing and proposed site slopes. Based on our analyses, it is our opinion that existing and proposed slopes should be stable.

Permanent fill slopes constructed from imported general structural fill should be sloped at an inclination no steeper than 2H:1V. Permanent cut slopes in natural silt soil or fill slopes constructed of silt soil should be sloped at an inclination no steeper than 3H:1V. Permanent cut and fill slopes should be seeded or sodded as soon as practical following construction to reduce the potential for erosion. Some sloughing and erosion should be expected until vegetation matures.

5.8. Weather Considerations

As stated previously, the on-site soil is moisture sensitive. As the moisture content of the soil increases, the strength decreases. During wet weather, as the soil approaches saturation, it becomes soft and muddy. Performing earthwork in these conditions will lead to disturbance of near-surface soil. During dry weather, the on-site soil should be less susceptible to disturbance and provide better support for construction equipment. In addition, drying of soil that is above its optimum moisture content is most effective during extended periods of warm, dry weather.

The wet weather season generally begins in October and continues through May in eastern Oregon. However, periods of wet weather may occur during any time of year. If wet weather earthwork is unavoidable, we recommend that the following steps be taken if surficial soil conditions begin to deteriorate.

- Stop earthwork activities during and immediately after periods of heavy precipitation.
- Grade the ground surface in and around the work area so that areas of ponded water do not develop, and water does not enter and collect in excavations and trenches.
- Accumulated water should be removed from the work area in accordance with the project Stormwater Pollution Prevention Plan (SWPPP).
- Areas of uncompacted soil should be sealed by rolling with a smooth-drum roller before precipitation occurs.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are not susceptible to disturbance.
- Construction activities should be scheduled so that the length of time that soil is exposed to moisture is reduced to the extent practical.

6.0 DESIGN REVIEW AND CONSTRUCTION SERVICES

The recommendations in this report are based on the previously stated assumptions and design information provided to us. We welcome the opportunity to discuss construction plans and specifications for this project as they are being developed. We believe GeoEngineers should be retained to review the geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in this report. Through our service to you on this project, we understand your project goals, objectives and preferences; the various assumptions that may have been made; and the many technical interrelationships involved. Consequently, we are more likely to recognize a problem for what it is, and to recommend the most effective solution.

GeoEngineers also maintains an accredited soil and material testing laboratory which allows us to provide special inspection and testing services in general accordance with the IBC and local building department requirements. Our services include inspection and/or testing of subgrade soil and structural fill placement and compaction.

7.0 LIMITATIONS

We have prepared this report for Consor for the proposed East Side Booster Station project in Pendleton, Oregon. Consor may distribute copies of this report to their designated design and construction team members and their authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering and environmental science practices in this area at the time this report was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix C, titled “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

FIGURES

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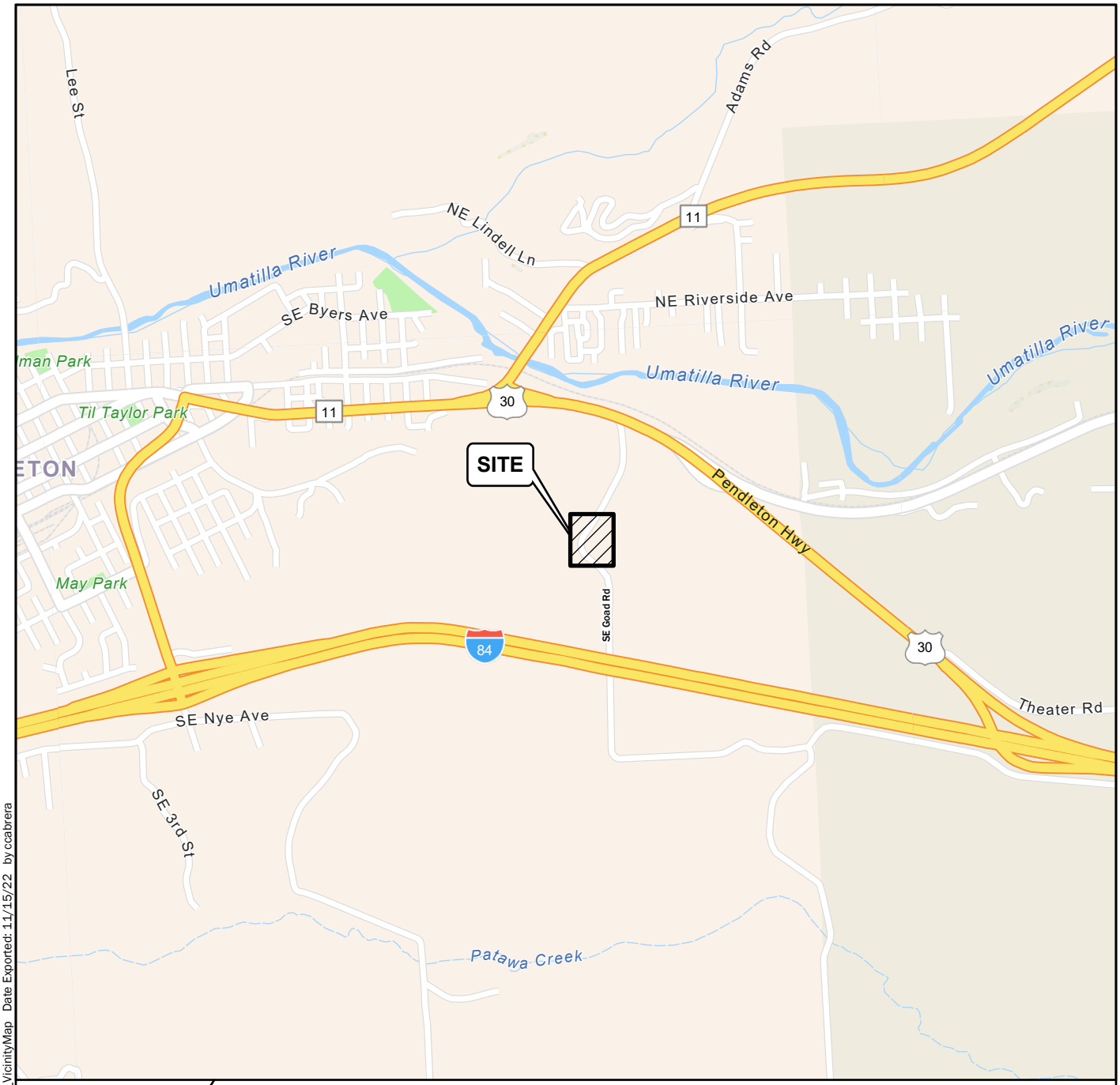

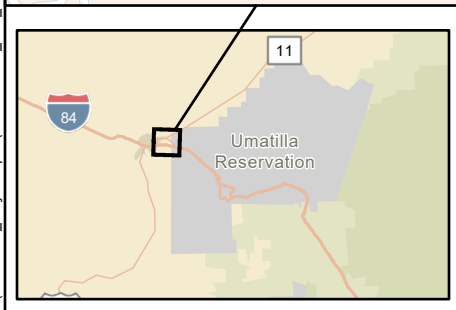

N

0 2,000

Feet

Source(s):
- ESRI

Coordinate System: NAD 1983 UTM Zone 10N

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

Vicinity Map

Proposed East Side Booster Station
Pendleton, Oregon

GeoEngineers

Figure 1

P:\8\8946003\GIS\8946003_Project\8946003_Project.aprx\8946003306_F01_VicinityMap Date Exported: 11/15/22 by ccabrera

Legend

Test Pit number and Approximate Location

Source(s):
- ESRI Imagery
- Drawing from Murraysmith

Coordinate System: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

N

0 60

Feet

Site Plan

Proposed East Side Booster Station
Pendleton, Oregon

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Figure 2

APPENDICES

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APPENDIX A
Field Methods, Exploration Logs and Geotechnical Laboratory Testing

APPENDIX A
FIELD METHODS, EXPLORATION LOGS AND GEOTECHNICAL LABORATORY TESTING

General

We explored soil, rock, and groundwater conditions at the site on November 3, 2022, by observing the excavation of nine test pits (TP-11 through TP-19) at the approximate locations shown on the Site Plan, Figure 2. Note that test pits TP-1 through TP-10 were excavated on the same day for a nearby project for the City of Pendleton and are not included in this report. The test pits were excavated using a John Deere 310 SK rubber-tired backhoe owned and operated by the City of Pendleton.

General Soil Sampling Procedures

The explorations were continuously monitored by a representative from GeoEngineers who classified the soil encountered, maintained detailed logs of the test pits showing stratigraphic changes and other pertinent information, obtained representative soil samples and observed groundwater conditions. Soil encountered in the test pits was classified in the field in general accordance with ASTM International (ASTM) D 2488, the Standard Practice for the Classification of Soils (Visual-Manual Procedure), which is described in Key to Exploration Logs, Figure A-1. Logs of the explorations are presented in Logs of Test Pits, Figures A-2 through A-10. The logs are based on interpretation of the field and laboratory data and indicate the depth at which subsurface materials, or their characteristics change, although these changes might actually be gradual.

Exploration locations were selected based on review of the proposed development and were staked in the field by the project surveyors.

Geotechnical Laboratory Testing

Soil samples obtained from the test pits were returned to our laboratory for further examination. Representative samples were selected for moisture content and percent passing the 200 sieve tests in accordance with ASTM test method D 1140 and moisture content determinations in accordance with ASTM D 2216. Results are presented on the test pit logs at the respective sample depths. One sample of conglomerate was tested for sieve analyses in accordance with ASTM C136. Results are presented in Sieve Analysis Results, Figure A-11.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel / Dames & Moore (D&M)

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

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Figure A-1

Date Excavated	11/3/2022	Total Depth (ft)	10	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0				TS	Approximately 4 inches of dark brown silt with organic matter (roots) (very soft, moist) (topsoil)			
					ML	Brown silt with sand (stiff, dry) (weakly cemented)			
	3		1 %F			Becomes moist	8	83	
	5		2 %F			Grades to sandy silt, stiff to very stiff	15	62	
	8		3			Becomes very stiff, pinhole voids present			

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-11

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-2
Sheet 1 of 1

Date Excavated	11/3/2022	Total Depth (ft)	12	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	Undetermined			Easting (X) Northing (Y)	Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Dark brown silt with organic matter (roots) (very soft, moist) (topsoil)			
	1				ML	Brown-white silt with sand (soft, moist) (occasional decomposed tan silt clusters and caliche nodules) (fill?)			Minor caving observed from 1 to 5 feet
	2		1						
	3					Becomes very soft			
	4								
	5		2 MC		ML	White silt (very soft, dry to moist) (ash like with low density) (fill?)	7		
	6								
	7								
	8								
	9		3		ML	Brown silt with trace organic matter (roots) (stiff, moist)			
	10								
	11								
	12								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-12

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-3
Sheet 1 of 1

Date Excavated	11/3/2022	Total Depth (ft)	12	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Dark brown sandy fine silt with organic matter (roots) (very soft to soft, moist) (topsoil)			
	1				ML	White-brown silt (very soft, dry to moist) (ash like, silt lobes, very low density) (fill?)			
	2		1						
	3				ML	Brown silt (soft, moist)			
	4		2 MC				20		
	5								
	6								
	7								
	8		3			Becomes medium stiff			
	9								
	10								
	11		4 SA		GP-GM	White-brown weakly cemented fine to coarse gravel with silt, sand and occasional cobbles (dense to very dense, moist) (weathered conglomerate)	13	10	
	12								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-13

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-4
Sheet 1 of 1

Date Excavated 11/3/2022	Total Depth (ft) 11.5	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed	
Surface Elevation (ft) Vertical Datum Undetermined		Easting (X) Northing (Y)		Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
			1		TS	Dark brown fine sandy silt with organic matter (roots) (very soft, moist) (topsoil)			
					ML	White silt (very soft, moist) (ash like, extremely low density) (fill?)			
	1								
	2		2						
	3								
	4								
	5		3 %F		ML	Dark brown sandy silt (soft to medium stiff, moist)	23	71	
	6								
	7					Occasional calcification at approximately 6½ feet			
	8								
	9		4 MC			Becomes stiff, weakly cemented	16		
	10								
	11								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-14

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-5
Sheet 1 of 1

Date Excavated	11/3/2022	Total Depth (ft)	9.5	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	Undetermined			Easting (X) Northing (Y)	Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Dark brown silt with fine sand and organic matter (roots) (very soft, moist) (topsoil)			
					ML	Brown silt (medium stiff, dry)			
	1								
	2								
	3		1			Becomes very soft to soft			
	4								
	5								
	6								
	7		2 MC			Becomes medium stiff	14		
	8		3		GP-GM	White-brown cemented fine to coarse gravel with silt, sand and occasional cobbles (very dense, moist) (weathered conglomerate)			
	9								

Test pit terminated at approximately 9½ feet below ground surface due to refusal on cemented gravel

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-15

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-6
Sheet 1 of 1

Date Excavated	11/3/2022	Total Depth (ft)	11.5	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
					TS	Approximately 5 inches of dark brown silt with trace organic matter (roots) (very soft, moist) (topsoil)			
					ML	Brown silt (medium stiff, dry to moist)			
	1								
	2								
	3	✓	1			Becomes very soft to soft			
	4								
	5								
	6					Occasional calcification, weakly cemented silt layers, several inches thick			
	7	✓	2			Becomes soft			
	8								
	9	✓	3 MC		ML	White-brown cemented silt with sand and occasional gravel (hard, moist)	18		
	10								
	11								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-16

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-7
Sheet 1 of 1

Date Excavated 11/3/2022	Total Depth (ft) 2	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum Undetermined		Easting (X) Northing (Y)	Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	1		1 %F		ML	Dark brown sandy silt (medium stiff, dry to moist)	10	60	Topsoil previously grubbed
	2								Infiltration test IT-1 rand at approximately 2 feet

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-17

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-8
Sheet 1 of 1

Date Excavated	11/3/2022	Total Depth (ft)	11	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	Undetermined	Easting (X) Northing (Y)		Coordinate System Horizontal Datum		

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0–4		1		ML	Dark brown silt with sand and occasional organic matter (medium stiff, dry to moist)			Topsoil previously grubbed
	4–7.5		2		ML	Dark brown silt with sand (very soft to soft, dry)			
	7.5–8.5		3 %F		ML	Dark brown sandy silt with occasional gravel (stiff, moist)	20	57	
	8.5–11		4		ML	Dark brown silt with sand and occasional gravel (stiff, moist) (occasional calcification present)			

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-18

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-9
Sheet 1 of 1

Date Excavated 11/3/2022	Total Depth (ft) 2	Logged By BKH Checked By DRL	Excavator Equipment John Deere 310 SK Backhoe	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum Undetermined		Easting (X) Northing (Y)	Coordinate System Horizontal Datum	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	1		1 %F		TS ML	Approximately 4 inches of dark brown silt with organic matter (roots) (soft, moist) Dark brown silt with sand and organic matter (roots) (very soft to soft, dry to moist)	12	76	
	2								Infiltration test IT-2 setup and ran at approximately 2 feet

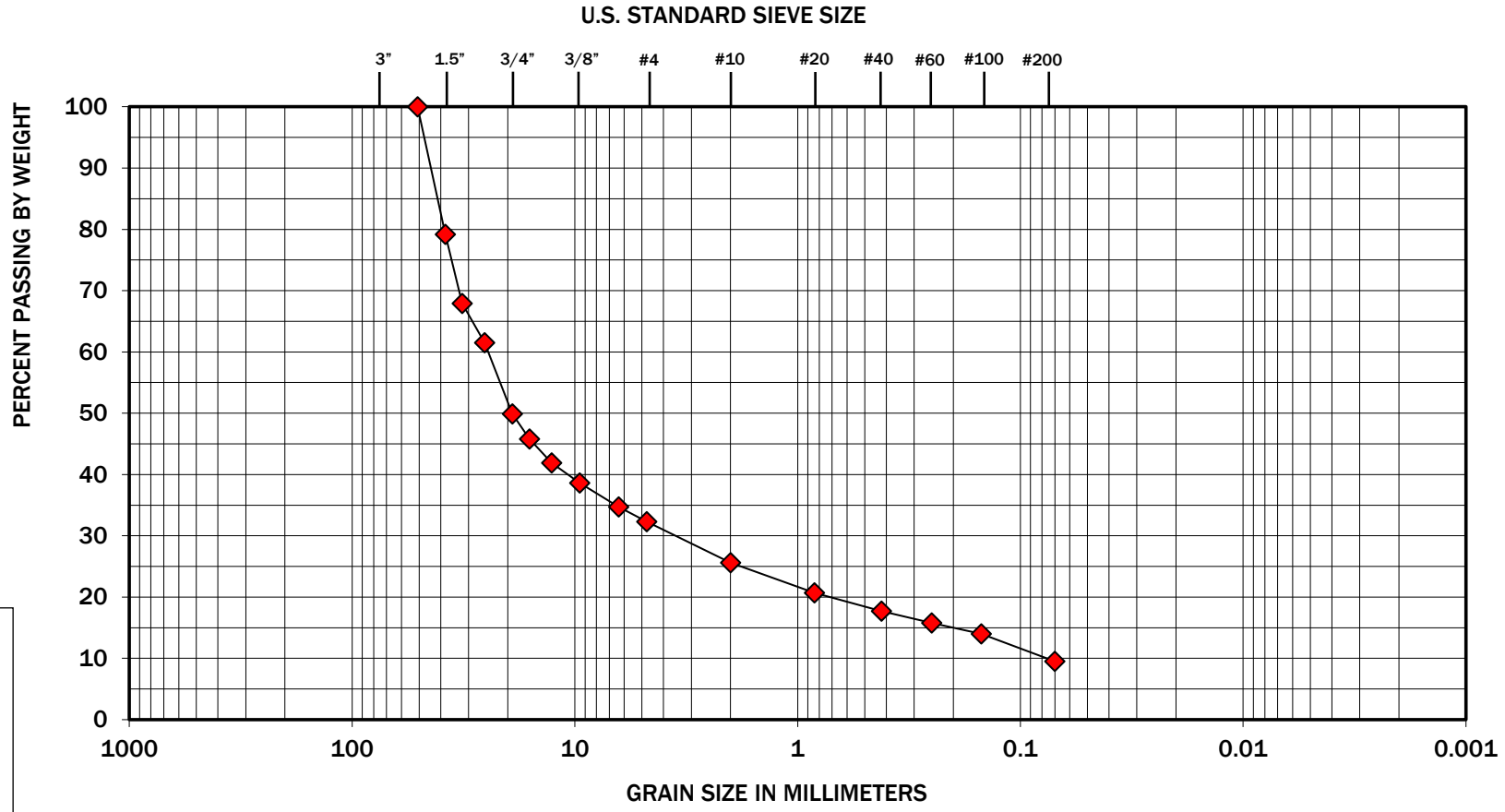
Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on . Vertical approximated based on .

Log of Test Pit TP-19

GeoEngineers

Project: Proposed East Side Booster Station
Project Location: Pendleton, Oregon
Project Number: 8946-003-06

Figure A-10
Sheet 1 of 1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	TP-13	11 - 12	13	Fine to coarse gravel with silt and sand

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM D 6913.

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Figure A-11

Proposed East Side Booster Station
Pendleton, Oregon

Sieve Analysis Results

APPENDIX B
Infiltration Test Data

Table B-1

Single-Ring Infiltration Test IT-1

Proposed East Side Booster Station
Pendleton, Oregon

Time of Day	Elapsed Time[1] *minutes*	Flow Rate[2] *in^3/hr*	Depth to Water[3] *feet*	Notes
8:40	0.0		2.00	Begin test, fill infiltrometer
8:50	10.0	326	2.04	Refill to 2.00 ft
9:00	20.0	244	2.03	Refill to 2.00 ft
9:10	30.0	163	2.02	Refill to 2.00 ft
9:20	40.0	163	2.02	Refill to 2.00 ft
9:30	50.0	81	2.01	Refill to 2.00 ft
9:40	60.0	81	2.01	Refill to 2.00 ft
9:50	70.0	244	2.03	Refill to 2.00 ft
10:00	80.0	81	2.01	Refill to 2.00 ft
10:10	90.0	163	2.02	Refill to 2.00 ft
10:20	100.0	81	2.01	Refill to 2.00 ft
10:30	110.0	244	2.03	Refill to 2.00 ft
10:40	120.0	163	2.02	Refill to 2.00 ft
10:45	125.0		2.00	End constant head test, begin falling head test
10:55	135.0		2.01	
11:05	145.0		2.02	
12:13	213.0		2.12	
14:20	340.0		2.29	

Notes:

[1]Elapsed time referenced to beginning of test.

[2]Flow rate estimated based on rate of water level drop over each measurement period

[3]Depth to water measured from the top of PVC well screen within infiltrometer ring Top of PVC 2.50 feet above bottom of test pit.

Test performed by GeoEngineers on 11/03/2022.

Infiltometer dimensions: 12 inch diameter; 28 inches tall; Ring embedded 12 inches into soil;

Table B-2

Single-Ring Infiltration Test IT-2

Proposed East Side Booster Station
Pendleton, Oregon

Time of Day	Elapsed Time[1] *minutes*	Flow Rate[2] *in^3/hr*	Depth to Water[3] *feet*	Notes
12:30	0.0		1.30	Begin test, fill infiltrometer
12:40	10.0	1303	1.46	Refill to 2.00 ft
12:50	20.0	570	1.37	Refill to 2.00 ft
13:00	30.0	407	1.35	Refill to 2.00 ft
13:10	40.0	407	1.35	Refill to 2.00 ft
13:20	50.0	326	1.34	Refill to 2.00 ft
13:30	60.0	407	1.35	Refill to 2.00 ft
13:40	70.0	326	1.34	Refill to 2.00 ft
13:50	80.0	326	1.34	Refill to 2.00 ft
14:00	90.0	163	1.32	Refill to 2.00 ft
14:10	100.0	326	1.34	Refill to 2.00 ft
14:20	110.0	326	1.34	Refill to 2.00 ft
14:30	120.0	326	1.34	Refill to 2.00 ft
14:35	125.0		1.30	End constant head test, begin falling head test
14:40	130.0		1.32	
14:45	135.0		1.34	
14:50	140.0		1.36	
14:55	145.0		1.38	
15:00	150.0		1.40	

Notes:

[1]Elapsed time referenced to beginning of test.

[2]Flow rate estimated based on rate of water level drop over each measurement period

[3]Depth to water measured from the top of PVC well screen within infiltrometer ring Top of PVC 1.80 feet above bottom of test pit.

Test performed in TP-19 at a depth of about 2 feet below site grade

Test performed by GeoEngineers on 11/03/2022.

Infiltometer dimensions: 12 inch diameter; 28 inches tall; Ring embedded 11 inches into soil;

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical and Environmental Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Consor for the project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the project, and its schedule and budget, GeoEngineers' services have been executed in accordance with our proposal dated October 20, 2022, and generally accepted geotechnical practices in this area at the time this report was prepared. GeoEngineers does not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed East Side Booster Station located east of Goad Road in Pendleton, Oregon. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure.
- elevation, configuration, location, orientation or weight of the proposed structure.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, GeoEngineers can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in GeoEngineers' scope of services, this report does not provide any environmental findings, conclusions or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical, Geologic and Most Environmental Findings are Professional Opinions

GeoEngineers' interpretations of subsurface conditions are based on field observations and chemical analytical data from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. GeoEngineers' report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Report Recommendations are Not Final

GeoEngineers has developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if GeoEngineers does not perform construction observation.

GeoEngineers recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by constructors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

GeoEngineers' geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as

they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialty.

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