HAM-75-8.91

PID 117526

PUMP STATION SPECIFICATIONS

OCTOBER 13, 2023

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SECTION 00 00 10

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SECTION 01 75 00

STARTING OF SYSTEMS/COMMISSIONING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. This Section includes general requirements for the commissioning of the Work and start-up and operation of systems and equipment.

1.02 SUMMARY

A. Starting, testing, and operating the completed Work including systems and equipment until Substantial Completion is achieved and operation of the completed Work including systems or equipment are accepted by the OWNER. CONTRACTOR shall cooperate and coordinate with the Owner's Representative in the operation, maintenance, and adjustment of the Work.

B. All Work under this Section shall be scheduled according to Section 01 32 16, Progress Schedules.

1.03 RELATED SECTIONS

A. Section 01 75 10, Testing, Adjusting and Balancing

B. Section 01 78 23, Maintenance and Operating Instructions

C. Section 01 79 00, Operational Demonstration

D. Section 01 79 10, Instruction of the Owner's Personnel

1.04 DEFINITIONS

A. Commissioning: Commissioning is the series of activities, or process, necessary to ensure that systems and equipment are designed, installed, functionally tested, started up and capable of being operated and maintained to perform in conformity with the design intent for the facility improvements. Commissioning

includes, but is not limited to factory testing, field testing, dry testing, wet testing, performance testing, manufacturer's checkout, start-up, and Operational Demonstration.

B. Factory Testing: Factory Testing is performance testing, operation testing, or documentation verification conducted in the production facilities, or specialized test facilities, or the equipment supplier. Such testing shall conform to the requirements of the individual sections of the Contract Documents. "Witnessed" Factory Testing shall mean that the testing is witnessed by the Owner or his designated representative.

C. Field Testing: Field Testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing.

D. Dry Testing: Dry Testing is performed by the Contractor without introducing either process material or other test material into the component, system, or unit process.

E. Wet Testing: Wet Testing is testing performed by the Contractor utilizing test material in the component, system, or unit process. Tankage shall be filled with test material to operating level.

F. Performance Testing: Performance Testing is performed by the Contractor to demonstrate system performance in accordance with the Project Manual requirements.

G. Manufacturer's Check-Out: Field inspection, testing, adjustments, and sign off by the approved representative of the Manufacturer, indicating that the component, system, or unit process meets the manufacturer's requirements.

H. Start-Up: Narrowly defined as placing a component, system, or unit process on-line. Start-up can be a commissioning activity or a normal operating activity.

I. Operational Demonstration: A commissioning activity performed by the Contractor wherein the Contractor operates and maintains a fully functional component, system, or unit process for a period of time after stable operation has been achieved.

1.05 SUBMITTALS

A. Quality Control Submittals:

1. Field Installation Reports – Submit reports by Manufacturer's Representative in accordance with Paragraph 3.04 of this Section.

B. Commissioning Documentation: CONTRACTOR shall prepare and submit all documentation for review and approval. The documentation shall include, but not be limited to, the following:

1. Certification by the preparer that he/she is the person responsible for the data, and that the data is authentic and accurate.

2. Certification by the CONTRACTOR or equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance: and that the equipment or unit process systems are suitable for Performance Testing.

3. Pertinent background information shall include, but not be limited to, the following:

a. Equipment or unit process systems Started-Up and Commissioned

b. Start-Up and Commissioning dates

c. Items or performance criteria tested clearly showing requirements and field data that verify requirements were met.

d. Names of witnesses for Start-Up and Commissioning

e. Any repairs, corrections, or modifications required for the equipment or unit process systems to successfully complete Start-Up and Commissioning.

f. Loop diagrams accurately depicting the installed condition of instrumentation and controls.

g. Any other important background information.

4. Appendix

a. A summary of all data used in the calculation, including source, formulas with all terms defined

b. Calculations for all data submitted, fully defined

c. Copies of all raw field data sheets, including those indicating sampling point locations, and notes

d. Production and/or operational data

e. Calibration procedures and work sheets for sampling equipment

f. Copies of calibration records for instrumentation

g. PLC Ladder logic documented with comments

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 EXAMINATION AND VERIFICATION OF CONDITION

A. The CONTRACTOR shall inspect systems and equipment prior to each start-up and verify their readiness for start-up. Conditions hazardous to equipment or personnel shall be corrected by the CONTRACTOR prior to start-up of equipment.

1. Start-up operations shall not proceed using temporary power or temporary instrumentation and control wiring. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.

2. Use of repair parts during start-up operations shall not be permitted, except in such situations where the actual on-site verification of such repair parts' operability is specified.

3. The CONTRACTOR shall verify that all initial copies of the Maintenance and Operating Instructions have received, from the Owner's Representative, an acceptable disposition as defined in Section 105 of the ODOT CMS, and the only outstanding item is the field verification of the Instructions.

B. On successful completion of Start-Up, potable water or stormwater shall be used for commissioning the equipment and unit process systems to show the equipment and unit process systems function properly. The Stormwater Duty Pumps shall run for a minimum of one minute each. The Low Flow Pumps Shall run for a minimum of two minutes each. Commissioning shall confirm the proper operation of the equipment and unit process systems, adjustments shall be made, and the equipment or unit process systems shall be optimized and brought into compliance with design criteria in preparation for Operational Demonstration.

C. Planning and Coordination of Activities with Owner's Representative: The CONTRACTOR shall coordinate all Start-Up and Commissioning activities for equipment and unit process. The CONTRACTOR shall develop a detailed Start-Up and Commissioning plan that includes the following as a minimum:

1. Description of the overall, general Start-Up and Commissioning process.

2. List of equipment and unit process systems included for Start-Up and Commissioning activities.

3. Detailed Start-Up and Commissioning sequence of activities.

4. Listing of staff and responsibilities for activities

3.02. PREPARATION

A. Prior to start-up of equipment or systems, all necessary test equipment shall be in place and operable.

B. Approved representative(s) of the Manufacturer and CONTRACTOR shall be present for the initial start-up of systems or equipment.

C. The CONTRACTOR shall request permission to start-up equipment, including electrical gear, and notify the Owner's Representative of the start-up through the use of the current version of the standard form, titled: Start-Up Request.

1. The Start-Up Request shall be submitted to the Owner's Representative a minimum of 72 hours before the scheduled start-up. Requests shall be made during normal working hours.

2. The CONTRACTOR shall provide all information in the first Section of the Start-Up Request form.

3. The Owner's Representative will indicate approval or disapproval of the request.

4. Approval of the request is based solely on impact on pump station operations. Approval does not relieve the CONTRACTOR of any responsibility for pump station and personnel safety.

5. The CONTRACTOR shall obtain the approved Start-Up Request prior to the system or equipment start-up.

6. If training is to be conducted in conjunction with the start-up this should be indicated on the Start-Up Request form. All requirements of Section 01690, Instruction of the Owner's Personnel must be met for training sessions.

7. Start-ups performed at the direction of the Owner's Representative, per paragraph 3.03.G. of this Section, do not require advance notification to the Owner's Representative.

D. Normal installation checks, such as for rotation, are not considered start-ups and do not normally require start-up notification. For all equipment and systems so designated in the Contract Documents, or so designated by the Owner's Representative, such checks shall be under the supervision of the approved representative of the

manufacturer, and shall be reviewed by the Owner's Representative.

1. All electrical apparatus which is energized, shall be clearly marked.

3.03 CONDUCT OF START-UP AND COMMISSIONING

A. Start-up:

1. All initial start-ups of equipment or systems shall be performed under the technical direction of the approved representative of the manufacturer.

2. Any lack of readiness of associated systems or failure of a system or equipment previously started prior to the date of Final Completion of the Project shall require additional initial start-up service to be performed, under the direction of the approved representative of the manufacturer.

3. The CONTRACTOR shall repair, replace or modify any equipment or system which fails to perform as specified in the Contract Documents. Such repair, replacement or modification of deficient work shall be performed under the terms of the General Conditions.

4. During the Operational Demonstration period per Section 01 79 00, Operational Demonstration and at other times when the system is on-line and an integral part of the Stormwater Pump Station operations and process, start-ups shall be performed as required by the Owner's Representative.

B. The CONTRACTOR shall be responsible for commissioning all work. Final acceptance shall be by Owner's Representative and OWNER.

C. The CONTRACTOR is responsible for the performance and operation of the systems and equipment during commissioning.

D. When OWNER personnel are operating systems or equipment, the CONTRACTOR shall make available, at all times, persons knowledgeable about the systems or equipment, to direct the OWNER personnel, through the Owner's Representative, in its operation.

E. The CONTRACTOR shall make all adjustments and corrections necessary to achieve normal, stable operation of systems. Adjustment and corrections shall be in accordance with Sections 01 75 10, Testing, Adjusting, and Balancing and 01 78 23, Maintenance and Operating Instructions.

F. Any failures of equipment or systems operated under the direction of the CONTRACTOR shall be considered deficiencies and shall be corrected in accordance with the General Conditions.

G. The CONTRACTOR shall attend commissioning meetings as called by the Owner's Representative in accordance with Section 01 31 19 paragraph 1.01.

H. During the Operational Demonstration period as defined in Section 01 79 00, Operational Demonstration and at other times, the work will be on-line and an integral part of the Stormwater Pump Station operations and process. The OWNER maintains control of Stormwater Pump Station operations and processes at all times. Therefore:

1. The CONTRACTOR shall not commence, resume, terminate, or suspend the operations without the permission of the OWNER and only in a sequence and manner suitable to the OWNER.

2. The CONTRACTOR shall immediately, on a 24 hour per day, 7 day per week basis, adjust or repair any malfunction in the work which in the opinion of the OWNER jeopardizes or may jeopardize the proper operation of the Stormwater Pump Station.

3. The CONTRACTOR shall not start-up, shut down, adjust, or otherwise alter the operation of any component, system, or unit process without the permission of the OWNER except in the case of an emergency and in accordance with the terms of the General Conditions.

3.04 QUALITY CONTROL

A. Reports of the Approved Representative of the Manufacturer:

1. The approved representative of the manufacturer shall prepare a daily report on each site visit for each system or

item of equipment inspected, adjusted, started-up, or worked on.

2. The report shall state the purpose of the visit, the representative's observations and conclusions, and recommendations for further visits or action.

3. The reports shall be submitted within 3 days of the visit.

+ + END OF SECTION + +

SECTION 01 75 10

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.01 GENERAL DESCRIPTION

A. This Section includes general requirements for the conduct of testing, adjusting, and balancing.

1.02 SUMMARY

A. Testing, adjusting, and balancing shall be performed in accordance with recognized industry standards and as specified in the Contract Documents.

1.03 RELATED SECTIONS

A. Section 01 75 00, Starting of Systems/Commissioning

B. Section 01 78 13, Project Record Documents

1.04 DEFINITIONS

A. Dry Testing:

Dry Testing is performed by the CONTRACTOR without introducing either process material or other test material into the component, system, or unit process.

B. Wet Testing:

Wet Testing is testing performed by the CONTRACTOR utilizing test material in the component, system, or unit process. Process Tankage shall be filled with test material to operating level.

C. Performance Testing:

Performance Testing is performed by the CONTRACTOR to demonstrate system performance in accordance with Contract Document requirements.

D. Factory Testing:

Factory testing is performance testing, operation testing, or documentation verification conducted in the production facilities, or specialized test facilities, of the equipment supplier. Such testing shall conform to the requirements of individual sections of the Contract Documents.

E. Field testing:

Field testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing.

1.05 SUBMITTALS

A. Factory Testing:

1. Submit Factory Test procedures for testing 60 days prior to the scheduled start of Factory Testing. Factory Testing procedures shall include:

a. Reference to industry standards required and details of compliance with those standards. Standard tolerances shall be noted and intended tolerances indicated.

b. Complete listing of equipment and instruments to be used for data collection.

c. Calibration histories for instruments and copies of calibration certificates

d. Copies of blank data collection forms

e. Sample calculations demonstrating methods of determining results of testing from raw data collected.

f. Detailed schematic representation of testing apparatus and equipment layout

g. Sample proposed test report

2. Submit a complete and detailed list of submittals pertaining to the equipment and any associated control panels to be tested including the date submitted and the current reviewed disposition of each line item. Pertinent submittals shall have received an acceptable disposition prior to the start of the Factory testing for each piece or component of the equipment to be tested.

3. Submit written narrative from the equipment or system supplier or manufacturer that a preliminary Factory Test has been successfully conducted to verify the preparedness of the testing facility and equipment prior to the actual Factory Test.

B. Quality Control Submittals:

Test Reports shall be submitted to the Owner's Representative within 48 hours of the completion, suspension, or termination of the test unless otherwise approved by the Owner's Representative. Submit Test Reports.

C. Project Record Documents:

Test, adjustment, and balancing data shall be recorded on all documents.

1.06 REGULATORY REQUIREMENTS

A. The requirements of this Section are in addition to those specified by Regulatory agencies. Except as specifically prohibited or modified by Section 01 40 00, Regulatory Requirements and Reference Standards, comply fully with all requirements of this Section.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The CONTRACTOR shall supply all materials and equipment used in testing, adjusting, and balancing.

B. Materials and equipment used shall be of good quality and suitable for the intended service. The use of miscellaneous items found at the job site is not acceptable.

C. Select capacity or range of test equipment to provide meaningful test results. Select pressure or differential pressure gauges so that test pressure is 50% to 75% of the gauge capacity.

2.02 FABRICATION

A. The CONTRACTOR shall fabricate temporary equipment used in testing.

2.03 SOURCE QUALITY CONTROL

A. All test instruments shall be calibrated to recognized standards, traceable to NBS standards, by the instrument manufacturer or a qualified independent calibration laboratory. Submit instrument calibration data for the Owner's Representative's review prior to the test.

PART 3 EXECUTION

3.01 EXAMINATION AND VERIFICATION OF CONDITION

A. Verify the equipment, component, or system is completely and correctly installed before beginning tests.

B. Review the design and installation of the system or equipment to ensure that the proposed test will not result in a hazard to personnel or equipment.

3.02 PREPARATION

A. Design, fabricate, and install test equipment before commencing the test.

B. Where required by the Contract Documents, or when required by the Owner's Representative, an approved representative of the manufacturer shall be on site to provide technical direction.

C. Notify and obtain approval of the Owner's Representative not less than 72 hours prior to each test. See Section 01 75 00, Starting of Systems/ Commissioning.

3.03 TESTING, ADJUSTING, AND BALANCING

A. Dry Testing:

1. All equipment and systems shall be tested, adjusted, aligned, lubricated, and balanced in accordance with the manufacturer's instructions prior to testing.

2. Test individual components prior to testing the system of which they are a part.

B. Wet Testing:

1. Test all equipment and systems with a test material, such as potable water, rain water or river water. If river water is available, CONTRACTOR shall submit a State of Ohio, Temporary Water Withdrawal Facility Registration Form, with the Ohio Department of Natural Resources, Columbus, Ohio. Potable water shall be used to test potable water lines. All costs, including materials and equipment, for delivery of the test material shall be at the CONTRACTOR's expense. Any cost to the OWNER for test material shall be backcharged to the CONTRACTOR. Test materials obtained from the OWNER are not guaranteed as to their pressure, quality or quantity available. Test each component or item of equipment to demonstrate compliance with the design criteria or range of criteria.

2. After testing, adjusting, and balancing, test all equipment and systems for a minimum of 72 hours under the design operating conditions utilizing test material.

3. Suspend or secure all tests in the event of test failures, or if hazardous conditions occur. Make repairs, replacements, or adjustments and re-start test in its entirety.

4. The CONTRACTOR will dispose of the test material to the approval of the Owner's Representative at no additional expense to the OWNER.

5. The CONTRACTOR shall clean all equipment systems and structures upon conclusion of testing, unless otherwise directed by the Owner's Representative, at no additional expense to the OWNER.

C. Factory Testing

1. Conform to the specific test requirements, as given in individual sections of the Project Manual. Provide all necessary assistance to OWNER and/or Owner's Representative personnel for all Factory Testing.

2. If equipment or materials fail or if testing must be extended beyond the original approved duration due to additional testing required as a result of the appearance of defects in the work or if testing could not be completed or conducted as outlined in the approved schedule, the cost of such re-testing shall be borne by the CONTRACTOR.

3. Delays to the CONTRACTOR's Detailed Construction Network as specified in Section 01 32 16, Progress Schedules due to failed, delayed or extended testing and the need for subsequent re-testing shall not entitle the CONTRACTOR to an extension of the contract time or additional cost. If the scheduling of the re-testing causes any activities shown on the CONTRACTOR's Detailed Construction Network to fall behind schedule to the extent that specific milestones or completion dates are in jeopardy, the CONTRACTOR shall prepare a recovery schedule and submit such to the Owner's Representative prior to the re-testing of the equipment.

D. Field Testing

Conform to the specific test requirements as given in individual sections of the Project Manual. Provide all necessary assistance to Owner's Representative personnel, at no additional cost to the OWNER or Owner's Representative.

3.04 FIELD QUALITY CONTROL

A. Submit Test Reports for all tests, successful or unsuccessful.

B. Tests shall be repeated per the General Conditions if results of testing fail to meet test criteria, whether the failure is identified in the field at the time of testing or through Test Report review.

+ + END OF SECTION + +

SECTION 01 78 23

MAINTENANCE AND OPERATING INSTRUCTIONS

PART 1 GENERAL

1.01 GENERAL DESCRIPTION

A. The CONTRACTOR shall prepare and furnish Maintenance and Operating Instructions for installation, maintenance and operation of all equipment as specifically required in the Project Manual. General Conditions. In addition to the requirements specified herein, other specific requirements for the Electrical Maintenance and Operating Instructions are included in Division 26.

1.02 SUMMARY

A. Work under this Section includes submittal of Maintenance and Operating Instructions as defined in Paragraph 1.04.

1.03 RELATED SECTIONS

A. Section 01 75 00, Starting of Systems/Commissioning

B. Section 01 75 10, Testing, Adjusting, and Balancing

C. Section 01 79 00, Operational Demonstration

D. Section 01 78 36, Warrantees and Guarantees

E. Maintenance and Operating Instructions of each Section in Divisions 2 through 46 of the Project Manual.

1.04 DEFINITIONS

A. USER-LEVEL DOCUMENTATION: This term shall mean operating instruction manuals, explanatory brochures, warranty and other service information, explanatory labels and placards, and all other such information routinely furnished to the end user of materials or equipment by the original equipment manufacturer (OEM), for

purposes of making the operation of the materials or equipment intelligible to that end user, and giving the same end user generalized means of determining the need for maintenance and/or routine maintenance information, such as lubrication requirements. Generally, documentation at this level shall be complete and conclusive as to installation and operation of materials or equipment, shall include complete information on required regular maintenance and adjustment, such as lubrication, but refers breakdown maintenance and other-than-routine adjustment to trained service entities.

B. DEALER-LEVEL DOCUMENTATION: This level of documentation includes all materials furnished under "User-level" documentation, plus additional service information for materials or equipment such as is ordinarily furnished by an OEM to its dealers and other sales representatives, for purposes of guiding dealer service personnel in diagnosis, adjustment, and repair of the materials or equipment. This documentation will generally consist of "User-level" documentation, plus schematics, diagnostic information, special test and adjustment procedures, servicing software, and complete OEM parts information. Dealer-level documentation should fully cover minor and major maintenance service, either "in the field" at the user's facility, or "on the bench" at the dealer's facility.

C. DISTRIBUTOR-LEVEL DOCUMENTATION: Distributor-level documentation continues beyond Dealer-level documentation and includes all materials furnished under "User-level" and "Dealer-level" documentation, plus any additional diagnostic, adjustment, and maintenance information necessary to provide complete rebuilding of materials or equipment under dedicated maintenance facility conditions. This is the level of documentation which shall be furnished to the Owner for almost all materials or equipment furnished, in this project and other Capital Improvements Projects. The Owner intends to generally provide complete maintenance service with its own forces to materials or equipment purchased by it, and entities desiring to furnish materials or equipment to capital improvements projects of the Owner are hereby advised of the Owner’s intention in this regard. Maintenance documentation as necessary for the Owner to perform Distributor-level maintenance as described herein shall be furnished by the OEM to the Owner, as described in these Contract Documents, and the OEM shall assert no claim that such information is proprietary.

D. DEPOT-LEVEL DOCUMENTATION: Depot-Level documentation continues beyond Distributor-Level documentation, and includes all materials furnished under "User-Level", "Dealer-Level", and "Distributor-Level" documentation, plus additional information which is necessary to the servicing of the supplied materials or equipment by a maintenance depot. A maintenance depot is defined as a maintenance facility having the ability to replace and recondition elements of the materials or equipment to achieve a "re-manufactured" state; that is, a like-new condition of operability. Generally, Depot-Level documentation shall include shop drawings, assembly drawings, manufacturing drawings, materials specifications, function specifications for purchased parts, and similar data required by the OEM to either manufacture parts and subassemblies or to purchase the same. The Owner has no intention to become a manufacturer, or to operate in any manner to limit enterprise by existing manufacturers and suppliers. Depot-Level documentation will generally only be required on specific parts of long-lived materials or equipment which the Owner anticipates may be in service for such a long period that parts and subassemblies may not be commercially available at some time in the future. The Owner is a robust, durable entity, and has experienced a number of instances in the past wherein parts and subassemblies were no longer available for older materials or equipment which needed to remain in service. Maintenance documentation as necessary for the Owner to perform Depot-Level maintenance as described herein shall be furnished by the OEM to the Owner, where specifically described in these Contract Documents, and the OEM shall assert no claim that such information is proprietary. Depot-Level documentation will only be required for particular elements of materials or equipment specifically denoted in these Contract Documents.

E. The Maintenance and Operating Instructions will be used by the OWNER to guide preventive and corrective maintenance, both routine and major. Maintenance and Operating Instructions shall include complete and specific information for use by the OWNER's operating and maintenance personnel. The CONTRACTOR is responsible for collecting, collating, and assembling the Maintenance and Operating Instructions.

F. Original Equipment Manufacturer (OEM) is the company that manufactured an item of equipment; or a component, part, or subassembly of an item of equipment.

G. Original, First Generation Copies are direct reproductions of the Manufacturer's master printing document(s).

H. "Point-to-Point" Diagrams, as used in these Contract Documents, shall show the exact routing of all wiring, circuit paths, piping, cabling, etc. of all components and subassemblies, drawn to include the termination points of all such, the specific part of each device to which connected, and all identifying information for the device to which connected and for the wiring circuit path, piping, cabling, etc. All exactly as extent in the real equipment.

1.05 SUBMITTALS

A. Procedure:

1. The CONTRACTOR shall prepare an initial submittal of 10 original/first generation copies of Maintenance and Operating Instructions and submit them for review to the Owner's Representative.

   a. In response to comments and requests from the Owner's Representative, the CONTRACTOR shall provide original/ first generation copies of revisions and additions to the Maintenance and Operating Instructions in the required number.

   b. All Maintenance and Operating Instructions shall be specific for the equipment. Any portions of the submittal not pertinent to the equipment or component shall be crossed out with a bold line or marked with "Does Not Apply", or clearly identify and without question the portions of the submittal that are pertinent. Submittals shall be rejected when this is not done. **NOTE: Highlighting of submittals is not an acceptable means of denoting information.** It either does not persist on copies of the submittal, or interferes with making photo copies.

2. After the initial Maintenance and Operating Instructions have received an acceptable disposition, the manual has been field verified and all final corrections have been made by the CONTRACTOR, 2 copies of an electronic version of the final Maintenance and Operating Instructions shall be submitted to the Owner's Representative. The electronic M & O

manual shall be in a multi-page Portable Document Format (PDF) format, fully searchable and unlocked. M & O documents shall be formatted complete with index page and table of contents. The electronic submittal shall be provided on an appropriately labeled CD.

B. Maintenance and Operating Instructions shall be fully "Distributor-Level" documentation throughout (Except as specifically noted in the Master Submittal List), as described in this Section and shall be complete enough to fully delineate the internal functions of all purchased encapsulated components or similar "black box" devices to the satisfaction of the Owner's Representative. Certain "Depot-Level" information may be required, as delineated in the specification Section(s) for the equipment.

1. Certain information, also categorized under this Section as Maintenance and Operating Instruction, is to be submitted with the product data to provide the Owner's Representative with information regarding the incorporation of the equipment into the work and with functional data to evaluate equipment operation. The requirements for this information are also identified in this Section and are to be incorporated as part of the Initial Maintenance and Operating Instructions submittal.

2. The Initial Maintenance and Operating Instructions shall be prepared, submitted, and shall have received an "acceptable disposition" prior to equipment being released for shipment. The Initial Maintenance and Operating Instructions shall contain, unless otherwise specified, not less than the following information:

a. Manufacturer's Data: Include general descriptive bulletins, brochures, or catalog sheets used to describe the equipment.

b. Operating Instructions/Operating Sequence Descriptions: These shall be complete, detailed written descriptions of the operating sequence of all control systems and operations in all modes. The descriptions shall be specifically prepared for this work and shall be fully referenced to control diagrams and system components. The descriptions shall include start-up and shut-down operations under manual, automatic and emergency (alarm) conditions

and any alternate operating modes. Descriptions of system reactions and sequencing including the operation of switches, lights, timers, relays, contacts, valves, motors, and equipment components shall be included. Interlock functions shall be fully described including system safety functions.

c. Manufacturer's Instructions: This shall include instruction for storage, installation, routine preventive maintenance, and lubrication. This data shall include instructions that describe the proper procedure for moving, supporting, and anchoring of equipment, including tolerances for settings and adjustment. Also included shall be the storage requirements and procedures to protect products prior to installation; and once installed prior to start-up/periods of prolonged shut-down; and proper storage of repair parts.

d. Parts List: Include assembly, exploded view illustrations, or sectional drawings with all parts identified. Part listings shall include descriptions, quantity (per assembly) required, and OEM part numbers.

e. Repair Data: Include instructions for assembly, disassembly, repair, and rebuilding of the equipment or component.

f. Electrical Diagrams: Schematic diagrams, wiring diagrams, point-to-point wiring diagrams, and logic flow diagrams.

g. Mechanical Diagrams: Schematic and point-to-point diagrams of all pneumatic, hydraulic, and other mechanical systems and piping.

h. Troubleshooting Data: Include procedures, forms, or checklists, outlines, and diagnostic aids and information.

i. Test Data: Include procedures, readings, and settings for testing and calibration.

j. Repair Parts and Maintenance Materials: List replacement parts, special tools, and consumable materials used in cleaning, maintenance, and repair.

k. Software/Programming Documentation: This documentation shall be referenced to the Operating Sequence Descriptions and shall include flow charts, program source code listings, and documentation ladder diagrams with detailed descriptions for each rung for the software provided. Information shall be provided to instruct and to familiarize the operator and shall be reviewed with the system programming to enable a step-by-step evaluation of the program. Notations, remarks, and labeling shall be provided on the program source code listing to indicate the program operation and function. Any additional narrative description of the program operation shall be provided to fully describe the system parameters and functionality in a clear and logical manner.

l. Supplier Data: Provide addresses, telephone numbers, and names of contact persons for the equipment manufacturer and manufacturer's representative. Include both regional (local) and home offices.

m. Warranties and Guarantees: Include terms and conditions of the warranty. Include the Manufacturer's Extended Express Warranty and any Special Express Warranties as specified in individual Section of Divisions 2 through 46 of the Project Manual in addition to the general warranty. All warranties shall conform to Section 01 78 36, Warranties and Guarantees. Draft warranties shall be submitted with the shop drawing submittals. Copies of the approved draft warranties are to be included in the Initial Maintenance and Operating Instructions submittal. Following substantial completion, copies of the executed final warranties shall be provided to the Owner’s Representative for insertion into the Final Maintenance and Operating Instructions.

n. Approved Submittals: Provide a complete list (including submittal numbers) of all approved

submittals pertaining to this Maintenance and Operating Instruction and their disposition.

3. Individual Sections of the Project Manual require Depot-Level information be submitted as part of the Initial Maintenance and Operating Instructions. Descriptions for Depot-Level Instructions can be found in this Section, subparagraph 1.04.B. The following is a list of Depot-Level Instructions that are specifically required by individual sections:

   a. Detailed Parts Lists: In addition to original equipment manufacturer's parts numbers, provide complete part descriptions, sizes, and materials of construction types and/or grades using appropriate industry standard designation codes. Provide universal part numbers for applicable items such as bearings, seals, and gaskets.

   b. Manufacturing Data: Scale drawings and supplementary information with complete dimensions, tolerances, finishes, features, materials, and treatments required for procurement of materials and manufacture of the part(s) or equipment.

4. Within 2 weeks of equipment delivery, submit ten copies of any maintenance, operations, and installation instructions shipped with the equipment which have not been included in the Initial Maintenance and Operating Instructions submittal.

5. Submit Additional Information as required by individual Sections of Divisions 2 through 46 of the Project Manual.

C. The CONTRACTOR shall verify the accuracy of Maintenance and Operating Instructions by visual and physical inspection of the installed equipment. The CONTRACTOR shall:

1. Perform complete field verification of all Maintenance and Operating Instructions in the presence of the Owner's Representative.

2. Do not perform field verification until the Initial Maintenance and Operating Instructions have received an acceptable disposition from the Owner's Representative.

3. Perform field verification after successful completion of Start-up, Testing, Adjusting, and Balancing per Sections 01 75 00, Starting of Systems/ Commissioning and 01 75 10, Testing, Adjusting, and Balancing and before scheduling or starting the Operational Demonstration in accordance with Section 01 79 00, Operational Demonstration.

4. Physically trace and verify the documentation of all wiring and piping.

5. Visually inspect equipment and components and compare configurations and nameplate information to Maintenance and Operating Instructions.

6. Submit any changes, additions, or deletions to the Maintenance and Operating Instructions identified during field verification to the Owner's Representative for review. Correct all errors from the Maintenance and Operating Instructions found in the installed system.

7. In the event changes are made to the equipment following field verification and the termination or completion of the Operational Demonstration, the CONTRACTOR shall submit a final supplement of approved revisions of the Maintenance and Operating Instructions in accordance with subparagraph 1.05.A. of this Section.

8. Notify the Owner's Representative 1 week before the scheduled field verification. The Owner's Representative may require changes in the field verification schedule.

9. After completion of field verification, and the Operational Demonstration, the CONTRACTOR shall submit 1 CD ROM copy of all corrected drawings or diagrams included in the Maintenance and Operating Instructions. The Final Maintenance and Operating Instructions will be compiled by the Owner's Representative utilizing as a basis, the Initial Maintenance and Operating Instructions plus all subsequent revisions provided by the CONTRACTOR.

10. The Owner's Representative shall perform final compilation and re-binding of the Initial Maintenance and Operation

Instructions into the Final version of such Instructions, after all changes thereto are complete.

1.06 SUBMITTAL FORMAT

A. Format:

1. All materials shall be first-generation from the original master, and shall be high quality copies.

2. All information included in each submittal or resubmittal shall be field verified and so noted by the CONTRACTOR.

3. All materials shall be punched for 3-hole binding at the left edge, via not less than 5/16-inch holes, on accurate 4 1/4-inch centers, with not less than 7/32-gage from sheet edge to hole perimeter. Center holes shall be exactly 5 1/2 inches from tops of sheets.

   a. The binding edges of all folded materials, and of all indexes, covers, and legend sheets, shall be reinforced with vinyl, mylar, or polyester tape prior to punching.

   b. Any material with inaccurate or overlapping punching shall be rejected.

4. All reproducible copies provided for drawings larger than 8 1/2 inches by 11 inches shall be on standard size material with outside dimensions of 11 inches by 17 inches or 22 inches by 34 inches. Odd size reproducibles which do not meet these standard print paper dimensions will be rejected.

   a. Each reproducible copy shall contain only 1 drawing. Multiple drawings on a single reproducible sheet will be rejected.

   b. Submittals shall be folded such that they display the drawing title in the lower right-hand corner.

   c. Reproducible copies shall be provided with a space for the Design Professional's stamp. This space is in addition to that required for the CONTRACTOR's approval stamp.

d. 8-½ inch by 11 inch submittal documents, for which copies are to be generated by photocopying, are not required to have a clear space for stamps.

5. The materials submitted for the Maintenance and Operating Instructions in accordance with this Section shall be suitable for final compilation by the Owner's Representative, and re-binding as Final Maintenance and Operating Instructions in 3-ring binders. No materials shall be thermal-, spiral-, or comb- bound.

6. All Maintenance and Operating Instructions shall be submitted in Tyvek-hinged, moisture-resistant pressboard ACCO #25071, binders, or approved equal. Maximum sheet capacity shall be 1 1/2 inch per binder. An identification label shall be fixed to the front cover and protected with clear vinyl or clear Mylar tape.

7. All Maintenance and Operating Instructions shall be submitted in the following format: Manuals shall be organized into sections or categories of information such as manufacturer's data, operating instructions, preventative maintenance, drawings, electrical and mechanical diagrams, troubleshooting data, test and adjustment procedures, parts list, repair parts and maintenance materials, software documentation, approved submittals and warranties and guarantees. Use indexed tabs and dividers to separate sections and include a table of contents. Any revisions to the Maintenance and Operating Instructions, as a result of the submittal review by the Owner's Representative or field verification, shall include revisions not only to the content of the manual but also to the indexed tabs and table of contents.

B. Standard Folding.

All Shop Drawings or other submittal information larger than 8-½ inches by 11 inches shall be submitted, punched, and folded. Reproducible copies shall not be folded, but shall be rolled and protected from crushing, tearing, or water damage.

++ END OF SECTION + +

SECTION 01 78 36

WARRANTIES AND GUARANTEES

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section provides procedures and requirements for warranting the Work. The enumerated warranties herein are in no way intended to abrogate any implied warranties as associated with goods supplied under this Contract.

1.02 SUMMARY

A. Work Included:

1. Preparation of Warranties for submittal

2. Requirements for the content and submittal of Warranties

1.03 RELATED SECTIONS

A. None

1.04 DEFINITIONS

A. Warranty:

1. There are 3 general types of warranties required for this Work; all are made to the OWNER:

a. CONTRACTOR's Express Warranty:

A formal statement that the CONTRACTOR warrants to the OWNER that materials and equipment furnished under the Contract are of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work is free from defects not inherent in the quality required or

permitted, that the Work conforms to the requirements of the Contract Documents, that the Work is complete and fully functional, and that any failure to conform to these stipulations, or the occurrence of any defects or failures in the Work, shall be remedied by the CONTRACTOR. Work not conforming to these requirements, including substitutions not properly approved and authorized, shall be considered defective. The CONTRACTOR 's Express Warranty excludes remedy for damage or defect caused by abuse, improper or insufficient maintenance, improper operation, or normal wear and tear under intended usage. If required by the Owner's Representative, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment furnished. The CONTRACTOR shall be aware that the CONTRACTOR 's Express Warranty is the warranty upon which the OWNER chiefly relies to insure the integrity and serviceability of the Work. The OWNER has little interest in any equipment manufacturer's usual warranty as such warranties are fraught with exclusions, provide inferior coverage to the CONTRACTOR 's Express Warranty, and generally have a substantially shorter term than the CONTRACTOR 's Express Warranty. The CONTRACTOR is hereby advised that the OWNER has no interest in tailoring activities to preserve, protect, and utilize the manufacturer's usual warranty on any equipment or system, and that the OWNER shall rely on the CONTRACTOR 's Express Warranty, plus the CONTRACTOR's Special Express Warranty and Manufacturer's Extended Express Warranties as are specified.

b. CONTRACTOR's Special Express Warranties:

The form, format and conditions of CONTRACTOR's Special Express Warranties are described in the various specification Sections of the Contract Documents. These are formal warranties above and beyond the CONTRACTOR's Express Warranty and manufacturer's standard warranties. These warranties may be based on performance, power consumption, maintenance projections or other

operating parameters. Extended warranties, service contracts and performance bonds are also included under this category. The CONTRACTOR shall provide a Maintenance Bond equal to 100% of the value for the Work that is to be warranted by the CONTRACTOR's Special Express Warranty as identified in the CONTRACTOR's Schedule of Values. The warranty duration and work covered by the bond shall be described in the related detailed specifications.

c. Manufacturer's Extended Express Warranties:

These are formal statements or certifications by manufacturers which warrant to the OWNER that products and equipment are free from defects in material and workmanship. These are warranties issued with products and equipment which supplement the CONTRACTOR 's Express Warranty and extend coverage past the expiration of the CONTRACTOR 's Express Warranty. Included with the Manufacturer's Extended Express Warranty data shall be notification of the availability of any extension to standard warranty, including terms.

B. Final and Substantial Completion are defined in the General Conditions.

1.05 SUBMITTALS

A. As a part of the submittals for each item of equipment or group of equipment items, include a DRAFT Warranty containing all of the language and terms specified.

B. Following completion of the terms for establishment of the Warranty specified, prepare Warranties for submittal using the following:

1. Warranties for products or portions of the Work, established on a particular date as specified herein, may be submitted as a group.

2. Label each submittal with the title "WARRANTY," the project name and effective date; the CONTRACTOR's name, address and telephone number.

3. A Table of Contents shall be included identifying each item with the number and title of specification Section and the name of the product or Work item.

4. Separate Warranty for each specification Section item with index tab sheets. Label tabs to conform to Table of Contents.

C. The Warranty shall contain, as applicable:

1. Effective starting date and end date of the Warranty period.

2. Statement of the terms and conditions of the Warranty, if any.

3. Statement that all Maintenance and Operating information has been provided and approved.

4. Statement that all training and training materials have been provided and approved.

5. Statement that the equipment or system has been reviewed and accepted by the manufacturer in accordance with provisions of the individual Sections in Divisions 2 through 16 of the Project Manual, as applicable.

6. Certification by the CONTRACTOR and/or Manufacturer that the statements noted above are true and correct. This certification shall be signed by a person authorized to sign documents on behalf of the CONTRACTOR.

D. Special warranties, as required by individual Sections in Divisions 2 through 46 of the Project Manual, shall be submitted in accordance with the requirements of this Section.

PART 2 PRODUCTS

2.01 WARRANTIES

A. Term or Period:

1. The CONTRACTOR's Express Warranty shall extend for 1 calendar year from the date of Substantial Completion of the Work or acceptance date of the product or portion of Work thereof, whichever is the later date. Special Express Warranties and Manufacturer's Extended Express Warranties shall have the term given in the specification Section describing them.

B. CONTRACTOR's Responsibilities:

1. During the Warranty period, the CONTRACTOR is responsible for repair or replacement of all failures and defects, exclusive of ordinary and routine maintenance and failures directly traceable to the lack thereof. This requirement shall be thoroughly explained by the CONTRACTOR to all prospective equipment suppliers. Repairs or replacements shall be performed in accordance with the General Conditions.

2. The provisions of any usual Warranties, terms of sale, etc., by suppliers shall not be substituted for this requirement, except where such provides an extended Warranty beyond the requirements of this Section.

PART 3 EXECUTION

3.01 EXECUTION OF WARRANTY

A. The approved DRAFT Warranty will be executed and placed in effect as the FINAL Warranty on the date of Final Completion of the Work for the specific equipment item or group named in the Warranty.

++ END OF SECTION + +

SECTION 01 78 43

REPAIR PARTS AND MAINTENANCE MATERIAL

PART 1 GENERAL

1.01 DESCRIPTION

A. General procedures and requirements for submitting repair parts and maintenance material. Requirements for repair parts and maintenance material are included in each Section in Divisions 2 through 46 of the Project Manual.

1.02 SUMMARY

Work under this Section includes submittals on repair parts and maintenance material, and the provision of such.

1.03 RELATED SECTIONS

A. Section 01 78 36, Warranties and Guarantees

B. Repair parts requirements of each Section in Divisions 2 through 46 of the Project Manual.

1.04 DEFINITIONS

A. Repair Part:

Those replacement parts identified by the Contract Documents to be furnished as repair parts, or, to be furnished by the product manufacturer, based on knowledge of the product service history, and recommended to be stored on site or specified to be provided with equipment.

B. Maintenance Material:

Materials used to maintain the product in appearance or function, which are not replacement parts. These include such items as servicing tools and equipment, paints and lubricants, or other items

as identified in individual Sections of Divisions 2 through 46 of the Project Manual.

1.05 SUBMITTALS

A. Product Data:

1. The CONTRACTOR shall submit a complete list of repair parts and maintenance materials for review and approval on a form provided by the Owner's Representative prior to the date of Substantial Completion.

2. Copies of the approved review list, marked to indicate actual verification of the presence of all items, shall be stored with the repair parts and maintenance materials.

3. Manufacturer's certificates and warranties required by subparagraph 2.01.B. of this Section shall be submitted with the list of repair parts and maintenance materials.

B. Warranty:

1. All repair parts and maintenance materials shall be warranted by the product manufacturer for form, fit, and function and shall be fully compatible with the product supplied. In addition, all repair parts shall be warranted against failure for a period not less than that specified for the product in accordance with Section 01 78 36, Warranties and Guarantees and Warranty or Special Warranty requirements of each Section in Divisions 2 through 46 of the Project Manual.

C. Special Tools and Repair Parts:

1. Provide shelf life data and shelf life expiration date, as applicable, for repair parts and maintenance materials.

PART 2 PRODUCTS

2.01 MATERIALS/EQUIPMENT

A. Repair Parts:

1. Repair parts shall be coated or packaged to prevent corrosion or deterioration during long-term indoor unheated storage. Any special storage environment required within this constraint shall be clearly marked on the packaging.

2. All packaging shall be clearly labeled with the product manufacturer's name and part number. This shall conform to the identification data provided on the list of repair parts and maintenance materials required by paragraph 1.05 of this Section.

3. Metal parts shall be packaged in sealed plastic wrappers with dispersion-type corrosion inhibitors included in the packaging.

4. Electric and electronic parts shall be packed in sealed plastic wrappers or hermetically-sealed containers. Desiccant cartridges shall be included in the packaging.

5. Plastic wrapping shall be sealed and shall not be less than 4-mils thick.

6. Electronic repair parts shall be installed in the requisite equipment:

    a. Brought to operating temperature

    b. Calibrated as required

    c. Tested

    d. Removed and repacked according to 2.01.A.4 of this Section for storage prior to acceptance.

B. Maintenance Materials Data:

1. Maintenance materials shall be provided in sealed, original manufacturer's packaging or containers. Packaging shall be suitable for long-term indoor unheated storage. Any special storage environment required within this constraint shall be clearly marked on the packaging.

2. All packaging shall be clearly labeled with the product manufacturer's name and part number. This shall conform to the identification data provided on the list of repair parts and maintenance materials required by paragraph 1.05 of this Section.

3. All tools and equipment shall be in new, unused condition. If any tools or equipment are used during construction, they shall be returned to the manufacturer for rebuilding and inspection, and shall be certified and warranted by the manufacturer to conform to all requirements for new material, or replaced with new tools or equipment.

PART 3 EXECUTION

3.01 USE OF PARTS AND MATERIALS

A. All repair parts and maintenance materials utilized during the start-up and operational demonstration of equipment or systems shall be replaced by the CONTRACTOR at no additional cost to the OWNER.

+ + END OF SECTION + +

SECTION 01 79 00

OPERATIONAL DEMONSTRATION

PART 1 GENERAL

1.01 GENERAL DESCRIPTION

A. Work Included:

A demonstration of the operation of all systems is required. This Operational Demonstration shall be conducted, coordinated and recorded by the CONTRACTOR in accordance with the requirements specified herein.

1.02 SUMMARY

A. Section Includes:

1. Requirements for the conduct and reporting of the Operational Demonstration. This work is additional to any other installation, shop and factory testing, field testing, dry testing, wet testing, performance testing, balancing, or adjustments required elsewhere in the Contract Documents.

2. Scheduling Work under this Section according to Section 01 32 16, Progress Schedules.

1.03 RELATED SECTIONS

A. Section 01 75 00, Starting of Systems/ Commissioning

B. Section 01 75 10, Testing, Adjusting, and Balancing

C. Section 01 78 23, Maintenance and Operating Instructions

1.04 DEFINITIONS

A. Operational Demonstration is defined in Section 01 75 00, Starting of Systems/ Commissioning.

B. Operational Demonstration Log: A chronological record of the status of the system and equipment during the Operational Demonstration. All changes in status or system parameters, adjustments, and results of tests shall be included. Entries shall be made, noting the date and time, at the occurrence of each event. Operational Demonstration Logs shall be on a form acceptable to the Owner's Representative.

1.05 SUBMITTALS

A. Quality Control Submittals:

1. Test Reports:

a. Operational Demonstration Log per subparagraph 3.04.A. of this Section.

b. Report of Operational Demonstration per subparagraph 3.04.B.2. of this Section.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 EXAMINATION AND VERIFICATION OF CONDITION

A. Before beginning the Operational Demonstration, the CONTRACTOR shall verify that:

1. All required construction activities are completed, including any activities by any entity that would interrupt the normal operations of the system. Coordinate with the Owner's Representative to resolve such conflicts.

2. All required testing, adjusting, and balancing is completed in accordance with Section 01 75 10, Testing, Adjusting, and Balancing.

3. Adequate parts and supplies for routine maintenance and replacement are on hand to support system operation through the demonstration period.

4. Start-up of equipment and systems per Section 01 75 00, Starting of Systems/ Commissioning has been completed.

5. All Repair Parts and Maintenance Materials have been delivered to the OWNER.

6. Certain Instruction of Operating Personnel (training) has been scheduled to take place during the Operational Demonstration where specified. All other training will occur within 45 days prior to initiation of Operational Demonstration. The training of Operations Personnel shall be scheduled to take place during the first half of the demonstration period, and the remaining training of Electrical, Instrumentation and Maintenance Personnel shall be scheduled to be complete before the end of the Operational Demonstration.

7. The field verification of the Initial Maintenance and Operating Instructions has been completed in accordance with Section 01 78 23, Maintenance and Operating Instructions.

3.02 PREPARATION

A. The CONTRACTOR shall provide 2 representatives, a prime and an alternate, who will be responsible for the Operational Demonstration. These representatives will:

1. Demonstrate the operation of systems and equipment to the OWNER’s operating personnel.

2. Direct maintenance and repair work, by either the CONTRACTOR or the approved representative of the manufacturer of the system components and equipment.

3. Maintain a log of the Operational Demonstration, as described herein.

4. Be available at all times during the Operational Demonstration to perform these duties.

B. Submit Start-up notification to the Owner's Representative per Section 01 75 00, Starting of Systems/ Commissioning.

3.03 OPERATIONAL DEMONSTRATION

A. The CONTRACTOR shall perform an Operational Demonstration of the work. Unless otherwise specified, the Operational Demonstration shall be a continuous 30-day, (720 hours) period during which the work is operated and maintained in a continuously on-line, fully functional process status.

B. The Operational Demonstration shall encompass the entire work, or the portion thereof designated for Substantial Completion.

C. Filling, draining, heating or cooling to temperature, stabilizing, adjusting, or other start-up activity time shall not be counted as Operational Demonstration time.

D. During the Operational Demonstration period, the CONTRACTOR shall provide 24 hour per day 7 days per week on-site supervision, in addition to the requirements of supervision as stated in the General Conditions. The CONTRACTOR shall provide labor and sufficient material to fully operate and maintain the work 24 hours per day, 7 days per week.

E. When systems are on-line, conform to the requirements of Section 01 75 00, Starting of Systems/ Commissioning, Paragraph 3.03.G. for alterations in the Stormwater Pump Station processes.

F. During the first half of the Operational Demonstration of the system and equipment, OWNER personnel will observe the CONTRACTOR's personnel operating systems and equipment. The CONTRACTOR shall cooperate with this familiarization process.

G. After the first 15 days of Operational Demonstration of system and equipment, operation of equipment will be assumed by the OWNER personnel, under the direction of the CONTRACTOR, as described in Section 01 75 00, Starting of Systems/ Commissioning.

The OWNER remains in control of the pump station processes per Section 01 75 00, Starting of Systems/ Commissioning. The CONTRACTOR shall provide technical direction in the operation of equipment and systems.

H. Start-up and operation of the system and all associated equipment shall be in accordance with the Initial Maintenance and Operating Instructions which have received an acceptable disposition from the Owner's Representative. If deviations from these instructions are necessary, these shall be noted in the Operational Demonstration Log, and subsequently submitted as revisions to the Maintenance and Operating Instructions per Section 01 78 23, Maintenance and Operating Instructions. During the period of time between the completion of the Operational Demonstration and the Date of Substantial Completion, the system and equipment will be operated and maintained under the requirements of the second half of the Operational Demonstration. The OWNER will not assume full responsibility for maintenance of the system and equipment until all conditions for Substantial Completion have been satisfied and both the CONTRACTOR and OWNER have accepted the Certificate of Substantial Completion.

I. All required maintenance and servicing prior to the Date of Substantial Completion shall be performed by the CONTRACTOR at the specified interval and as necessary. All maintenance and servicing shall be noted in the Operational Demonstration Log.

J. All outages of equipment, system(s), or the utilities should be noted in the Operational Demonstration Log. Pump station outages are considered a part of normal system operation and will not invalidate the Operational Demonstration. The CONTRACTOR is responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage. Outage time is not to be included in the Operational Demonstration period.

K. The CONTRACTOR shall attend operational coordination meetings as called by the Owner's Representative to review operating conditions of equipment and systems.

L. If, during the Operational Demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, the Operational Demonstration shall be considered to have failed, and the work shall not be considered to be Substantially Complete as defined in the General Conditions and the Owner's Representative shall so notify the CONTRACTOR in writing. If, during the Operation Demonstration, the provisions of the General Conditions are evoked to stop the work, the Operational Demonstration will also be considered to have failed.

M. Upon failure of the Operational Demonstration, the CONTRACTOR shall promptly remedy any defects in the work and shall promptly reschedule and re-start the complete 30-day, (720 hours) Operational Demonstration time period. No Operational Demonstration time will be considered to have accrued to any part of the work by reason of a failed Operational Demonstration.

N. During the Operational Demonstration, the OWNER may require or permit the Operational Demonstration to be suspended:

1. As provided in the General Conditions.

2. Upon the written request of the CONTRACTOR, to correct or adjust the work, when in the judgment of the Owner's Representative such required correction or adjustment is insufficient to deem the Operational Demonstration to have failed.

3. If the Operational Demonstration is suspended for any reason except failure, Operational Demonstration time shall accrue to the work from the time of the beginning of the Operational Demonstration to the time of the suspension.

4. If the Operational Demonstration is suspended at the request of the CONTRACTOR, the CONTRACTOR shall continue operation and maintenance of the work without additional charges to the OWNER, according to all provisions of this Section, and to the extent required by the OWNER. No Operational Demonstration time shall accrue to the Work during the period of suspension.

O. Completion of the Operational Demonstration does not relieve the CONTRACTOR of its other requirements for Substantial Completion as required by the Contract Documents.

P. Prior to the Operational Demonstration, all parts of the work designated for the Operational Demonstration shall have passed all required tests as specified. No testing shall be allowed during the Operational Demonstration.

3.04 REPORTING

A. Daily: copy of the Operational Demonstration Logs shall be submitted to the Owner's Representative by 9:00 a.m., the following day.

B. Within 2 weeks of the termination or completion of the Operational Demonstration, the CONTRACTOR shall submit for approval:

1. Any changes to the Maintenance and Operating Instructions, in accordance with Section 01 78 23, Maintenance and Operating Instructions.

2. A report of the Operational Demonstration, describing the equipment utilized and any repairs, modifications, adjustments, or other work performed during the demonstration period.

C. In the event the conduct of the Operational Demonstration or the submittals are unacceptable to the Owner's Representative, the CONTRACTOR shall perform the additional work or demonstrations required per the General Conditions.

+ + END OF SECTION + +

SECTION 01 79 10

INSTRUCTION OF THE OWNER'S PERSONNEL

PART 1 GENERAL

1.01 DESCRIPTION

A. General requirements for the conduct of training of permanent pump station operating personnel on the care, maintenance and proper operation of the equipment. Specific requirements for training materials and for training are included in the individual Sections of the Contract Documents.

1.02 SUMMARY

A. Work Included:

Except as otherwise specifically provided in individual Sections of the Project Manual, work under this section includes the preparation of the detailed lesson plans and the conduct of detailed training for permanent pump station operating personnel. Training shall be conducted on all components of equipment, as specified in individual Sections of Divisions 2 through 46 of the Project Manual.

1.03 RELATED SECTIONS

A. Section 01 79 00, Operational Demonstration

B. The Paragraph entitled Submittals, of each Section in Divisions 1 through 46, of the Project Manuals.

C. The Paragraph entitled Training or Instruction of Owner's Personnel, of each Section in Divisions 1 through 46 of the Project Manuals.

1.04 DEFINITIONS

A. Lesson Plan:

A Lesson Plan is a submittal containing a statement of the instructional objectives of the training, a training outline, credentials of the instructor, audio/visual requirements, a listing of training materials to be used, and the desired schedule times and dates.

B. Training Aid:

A mock-up, model, sample, or other device used during a training class to help demonstrate the maintenance, operation, or control of equipment.

1.05 SUBMITTALS

A. Submittal of Instructor's credentials, Lesson Plans, instructional materials, training aids, and other training information required by the individual Sections in Divisions 2 through 46 of the Project Manual shall be coordinated with the Training Schedule.

B. At least thirty copies of instructional materials used for training to be provided at time of the first training session.

C. Provide two copies of all audio/visual aids utilized during training including films, slides, mock-ups, videotapes, DVDs or other training aids. All multimedia video shall be submitted in either Audio Video Interleave (AVI) format or Moving Pictures Expert Group (MPEG) format.

D. Submit the following:

1. Proposed Training Schedule for the entire Contract showing tentative dates for each training session as specified in Divisions 2 through 46 of the Project Manual; include number, type and duration of each session. This schedule shall be submitted 120 days prior to the commencement of any individual training being performed.

2. The detailed credentials of the representative of the equipment manufacturer who is to be the course Instructor for each category and type of training. Include Instructors name, education, knowledge of equipment, experience as a trainer and employment history with the manufacturer. Include specific details of Instructor's experience pertaining to the operation and maintenance of, and training for the equipment or system specified. These credentials shall be

submitted 60 days prior to the commencement of any training.

3. The Lesson Plan shall be submitted sixty (60) days prior to the commencement of any training and shall cover all components of equipment, regardless of source of supply or manufacturer, and shall include:

   a. A title page containing: Title of the Lesson Plan, product name and model of equipment; name of manufacturer, manufacturer address and phone number; name and phone number of manufacturer's contact; job location – Columbus, Ohio – (Name of Facility); contract no.; specification number; CONTRACTOR name, address and phone number; subcontractor's name, address, phone – if applicable; submittal number assigned by CONTRACTOR; and submittal date.

   b. A table of contents listing the headings: instructional objectives; training outline; credentials of Instructor(s); audio/visual requirements; training materials to be used.

   c. A detailed instructional objective statement on the goal(s) intended to have been achieved by the end of the training session.

   d. The credentials of Instructors are to include name; education; knowledge of equipment; experience of trainer; and employment history with manufacturer.

   e. The audio/visual requirements listing specific equipment that is to be provided by the CONTRACTOR for training purposes.

   f. A list of all training materials to be used. An initial Maintenance and Operations (M & O) Instruction Manual, which has received an acceptable disposition, for the equipment shall be required to be utilized by the Instructor in the training and therefore shall be included on this list.

g. A request of schedule dates and times for each training session.

h. A training outline indicating the category of training (maintenance and operation, electrical and instrumentation or system); description of the session; length, and type (classroom or field). The training shall include as a minimum:

1) Electrical and Instrumentation Training: System (Equipment) Overview:

a) Describe system (equipment) fundamental operating principals and dynamics.

b) Identify system’s (equipment's) mechanical, electrical and electronic components and features. Review system (equipment) wiring diagrams and process and instrumentation diagrams.

c) Identify support systems (equipment) associated with the operation (e.g., air intake filters, valve actuators, motors).

d) Identify and describe safety precautions and potential hazards related to maintenance.

e) Identify and describe in detail safety and control interlocks.

f) Identify and describe alarm conditions and response to alarms.

g) Cover the supply of power to process equipment and related appurtenances, lighting, etc.

h) Cover low voltage controls, monitoring devices, etc.

2) Electrical and Instrumentation Training Equipment Preventive Maintenance (PM):

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

b) Define the recommended PM intervals for each component.

c) Provide lubricant and replacement part recommendations and limitations.

d) Describe appropriate cleaning practices and recommend intervals.

e) Identify and describe the use of special tools required for maintenance of the equipment.

f) Describe component removal and installation, and disassembly and assembly procedures.

g) Perform at least 2 "hands-on" demonstrations of preventive maintenance procedures.

h) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

i) Define recommended torque settings, mounting, calibration and alignment procedures and settings, as appropriate.

j) Describe recommended procedures to check or test equipment following a

corrective repair.

3) Electrical and Instrumentation Training Equipment Troubleshooting:

   a) Define recommended systematic troubleshooting procedures.

   b) Provide component specific troubleshooting checklists.

   c) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

4) Maintenance and Operation Training: System (Equipment) Overview:

   a) Describe system (equipment) operating (process) function and performance objectives.

   b) Describe system (equipment) fundamental operating principals and dynamics.

   c) Identify system’s (equipment's) mechanical, electrical and electronic components and features.

   d) Identify support systems (equipment) associated with the operation (e.g., air intake filters, valve actuators, motors).

   e) Identify and describe safety precautions and potential hazards related to operation.

   f) For systems (equipment) comprised of several components: Identify and describe in detail each component's function. Where applicable, group related components into subsystems. Describe subsystem functions and their

interaction with other subsystems.

g) Identify and describe in detail safety and control interlocks.

5) Maintenance and Operation Training, Operation of Equipment:

a) Describe operating principles and practices.

b) Describe routine operating, start-up and shutdown procedures.

c) Describe abnormal or emergency start-up, operating, and shutdown procedures that may apply.

d) Describe alarm conditions and responses to alarms.

e) Describe routine monitoring and record keeping procedures.

f) Describe recommended housekeeping procedures.

6) Maintenance and Operation Training, Troubleshooting:

a) Describe how to determine if either corrective maintenance or an operating parameter adjustment is required.

4. Once the Lesson Plan submittal has received an acceptable disposition but at least 3 weeks prior to the actual commencement of the training, CONTRACTOR shall submit the detailed training material as a Power Point presentation in an electronic format (either DVD, CDR, or flash drive/micro storage) with appropriate labeling. In addition to the electronic format the Power Point material shall be provided in hardcopy for Owner's Representative review and approval. The text and lettering on the presentation slides shall not be smaller than 12 font size and shall be black in

color. Slides shall have an appropriate light colored background, resulting in a high contrast between the text and background.

5. Sample Evaluation Form: Submit with Lesson Plan a sample Evaluation Form. Form shall include area for comments and evaluation of Instructor, classroom training and field instruction. Form shall identify Contract name and number, Specification Section, Job location, date and time of training, title of training session, name of manufacturer, model number of equipment, Instructor name, and CONTRACTOR and Subcontractor's name.

PART 2 PRODUCTS

2.01 QUALIFICATIONS OF INSTRUCTOR

A. The course Instructor shall be knowledgeable and experienced in the details of operation and maintenance of the equipment.

B. The Instructor must be knowledgeable of the equipment's application specific to this work.

C. The Owner's Representative will reject Instructors who are deemed not in compliance with the above stated minimum qualifications. The CONTRACTOR will submit for approval alternate Instructors for consideration. No additional cost will be allowed for replacement of Instructors who are unacceptable to the Owner's Representative.

PART 3 EXECUTION

3.01 EXAMINATION AND VERIFICATION OF CONDITION

A. The training site for the classroom instruction will be provided by the OWNER. The Owner's Representative will provide this location which will be in the limits of Franklin County.

B. The CONTRACTOR shall coordinate and verify to ensure that, prior to the scheduled training time(s):

1. The equipment is ready for Operational Demonstration in accordance with Section 01 79 00, Operational Demonstration.

2. That all associated construction required to operate the equipment in all normal and anticipated operating modes is complete.

3. That the equipment area is well lit and unobstructed, so that all training class attendees may access, hear, and view the training.

4. That the equipment area is free of construction activities that could present a hazard to training class participants.

5. That adequate training materials, as required by paragraph 1.05 of this Section, are on hand for use during the training session.

6. Any representatives of interfacing CONTRACTORS or equipment suppliers needed to perform supporting operations allowing demonstration of equipment operation, have been notified and will be available.

3.02 PREPARATION

A. Videotaping of all training will be conducted by the Owner's Representative. Before the start of training the CONTRACTOR, and the Owner's Representative will review the training site(s) to establish acceptable sight lines, lighting and locations for the participants.

B. Training classes shall be scheduled through the Owner's Representative. Training shall begin within 45 days to the beginning of the Operational Demonstration period. Certain training sessions will occur only during the Operational Demonstration period as specifically noted in the Contract Documents.

C. Training classes shall be conducted and separated for the following personnel:

1. Maintenance and Operation

2. Electrical and Instrumentation

3. Systems Training

D. Audio-visual equipment available at the OWNER's training sites include:

1. Blackboards and/ or Whiteboards

E. Verify training materials are compatible with all equipment. The CONTRACTOR is responsible for providing other audio/visual equipment and training aids as needed.

F. Classroom and field instruction where specified shall be provided for each group. Field instruction will include attention to hands-on familiarization with the actual equipment. Training hours as required in the Contract Documents do not include travel, set-up or cleanup time by the Instructor.

G. Training may be either "hands-on" or "classroom" as specified. If not specifically noted, provide hands-on training. For hands on training, the Instructor will demonstrate all operations of the equipment and may be expected to show assembly and disassembly procedures, maintenance procedures, replacement procedures, and the like. Hands-on training will generally occur at the installed location of the equipment or material unless mock-ups are approved in the Lesson Plan and provided by the CONTRACTOR. Such mock-ups will become property of the OWNER after the training sessions unless previously requested in the Lesson Plan.

H. Systems Training:

The DP will provide a detailed description of the system design, intended operation, and interactions of systems components. The CONTRACTOR's portion of Systems Training will provide additional detail descriptions of system's components and their interface with each other and other systems. CONTRACTOR's personnel for system training will be the same personnel who provided Maintenance and Operations training and Electrical and Instrumentation training.

I. To accommodate the OWNER's shift schedules, training shall be conducted during the following times:

1. Maintenance and Operations Sessions:

a. First Shift:

Days:	Tuesday Wednesday Thursday
Times:	7:30 a.m. to 10:30 a.m. 11:30 a.m. to 2:30 p.m.

b. Second Shift:

Days:	Tuesday Wednesday
Time:	3:00 p.m. to 10:30 p.m.

c. Third Shift:

Day:	Thursday
Time:	11:00 p.m. to 6:30 a.m.

d. Fourth Shift:

Days:	Tuesday Wednesday
Time:	11:00 p.m. to 6:30 a.m.
Day:	Thursday
Time:	3:00 p.m. to 10:30 p.m.

2. Electrical and Instrumentation Sessions:

Days:	Tuesday Wednesday Thursday
Times:	7:00 a.m. to 10:30 a.m. 11:30 a.m. to 2:30 p.m.

3. System Training:

Days:	Tuesday Wednesday Thursday

Times: 7:30 a.m. to 10:30 a.m.
11:30 a.m. to 2:30 p.m.

3.03 CONDUCT OF TRAINING

A. All topics of the approved Lesson Plan shall be discussed, in the classroom or the field, in complete and sufficient detail to allow pump station operating personnel to knowledgeably operate and maintain the equipment in accordance with manufacturer's recommended procedures and safety considerations during all anticipated operational and maintenance situations.

B. Safety concerns and features intended to enhance safety should be specifically addressed.

C. Tasks required to maintain the warranty should be specifically addressed.

D. Frequent reference shall be made to the Maintenance and Operating Maintenance instructions.

E. Address all questions and comments proposed by the training session participants as they are raised to the maximum extent practicable. If questions or comments cannot be addressed during the training session, additional materials and/or training may be required as determined by the Owner's Representative.

F. If any training session exceeds 3 hours in duration, provide a 1/2-hour break.

G. Cooperate with the Owner's Representative's videotaping personnel to ensure that all parts of the training session are legible or audible on the final tape. The Instructor must repeat all questions to ensure that they are audible. Final acceptance of the training is contingent on the acceptability of the videotape.

H. The CONTRACTOR will be backcharged for cancelled training classes if the Owner's Representative is not notified at least 72 hours prior to scheduled training.

I. Training Sessions shall be attended not only by the OWNER's Operating Personnel but also by members of the Owner's Representative or any other entities designated by the OWNER.

3.04 EVALUATION

A. Immediately following training, the Instructor shall pass out an evaluation form to the OWNER's personnel. This form shall provide a means for the OWNER's personnel to comment on the Instructor and the quality, completeness, and value of the session.

B. Evaluation Forms shall be collected, along with the Attendance Sheet at the end of each training session and the original documents shall be submitted to the Owner's Representative for use in determining if additional training is required by the CONTRACTOR. If additional training is required due to the material as outlined in the Lesson Plan not being covered correctly or in its entirety or the inability of the Instructor to answer questions pertaining to the operation and maintenance of the equipment, or if the training aids or equipment fail to operate as intended, the CONTRACTOR shall provide such additional training at no additional cost to the OWNER.

+ + END OF SECTION + +

SECTION 09 91 10

PAINTING

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all painting Work.

    a. General Contractor shall be responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included in the general, HVAC, plumbing and electrical contracts as described in this Specification.

2. Extent of painting Work is shown and specified. Painting Work shown in schedules on Drawings does not provide Contractor with complete indication of all painting Work. Contractor is directed to Section 2.4 herein where all surfaces of the generic types specified in Section 2.4 shall be prepared and painted according to their status, intended function and location in the Work, using the painting system for that surface, function and location as specified, whether or not indicated on any schedule or Drawing.

3. Types of painting Work required include, but are not necessarily limited to, the following:

    a. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by Owner, are included in the Work, except as otherwise shown or specified.

b. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative toppings on those items and surfaces to remain which are identified to receive a painting system under this Section, in order to provide surfaces acceptable for application of painting system specified.

c. Approved stepped-down job mock-ups for all painting systems showing all components of the surface preparation and paint system application before the start of any Work. Check all dry film thicknesses, demonstrate methods of surface preparation and methods of application in addition to obtaining approval from Engineer of colors and textures to be used in the finished Work.

4. The term "paint" in this Section includes pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate or finish coats.

5. Paint all new surfaces and items except where the natural finish of the material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note, or specified as a surface not to be painted. The term "exposed" in this Section means all items not covered with cement plaster, concrete or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. The requirements for "exposed-to-view" surfaces are specified in Section 3.4.A.4.a. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.

6. Heating, ventilating, and air conditioning items to be painted include, but are not limited to, the following:

    a. Piping, pipe hangers, and supports.

    b. Heat exchangers.

    c. Tanks.

d. Ductwork and insulation.

e. Motors, mechanical equipment, and supports.

f. Accessory items.

7. Electrical items to be painted include, but are not limited to, the following:

a. Exposed conduit and fittings.

b. Switchgear, panels, junction boxes, motor control centers, motors and accessories.

B. Coordination:

1. Review installation, removal and demolition procedures under other Sections and coordinate them with the Work specified herein.

2. Notify other contractors in advance of the surface preparation and painting Work included in this Specification to provide them sufficient time for installation, removal, demolition and coordination of interrelated items that are included in their contracts and that must be installed, removed or demolished in coordination with the painting Work.

3. Coordinate the painting of areas that will become inaccessible once equipment and similar fixed items have been installed.

4. Coordinate primers with finish paint materials in order to provide primers which are compatible with finish paint materials used. Review other Sections and other Contracts in which primed surfaces are to be provided in order to ensure compatibility of the total painting system for the various surfaces. Contractor shall be responsible for coordinating the compatibility of all shop• primed and field-painted items in other Sections.

5. Furnish information to Engineer on the characteristics of the finish materials proposed for use, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify Engineer in

writing of anticipated problems using the specified painting systems with surfaces primed by others. Reprime all factory-primed equipment and other factory-primed items that are damaged or scratched.

C. Work Not Included: The following categories of Work are not included as part of the painting Work, or are included in other Sections:

1. Shop-Priming: Shop-priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-built heating and ventilating and electrical equipment or accessories shall conform to applicable requirements of this Section but are included under other Sections.

2. Pre-finished Items:

    a. Items furnished with such finishes as baked-on enamel, porcelain and polyvinylidene fluoride shall only be touched up in the field by Contractor using Supplier's recommended compatible field-applied touch up paint.

    b. Items furnished with such finishes as chrome plating, anodizing, or where the natural oxide of the item forms a barrier to corrosion, whether factory or Site form ed, such as copper, bronze or muntz metal.

3. Concealed Surfaces: Nonmetallic wall or ceiling surfaces in areas concealed from view and generally inaccessible areas such as furred spaces, pipe chases and duct and elevator shafts.

4. Concrete surfaces, unless otherwise shown or specified.

5. Concrete floors.

6. Exterior face of architectural precast concrete.

7. Corrosion-Resistant Metal Surfaces: Surfaces of zinc, terne metal and stainless steel.

8. Operating Parts and Labels:

a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and dam per operators, linkages, sensing devices, interior of motors and fan shafts.

b. Do not paint over labels required by building code or other governing authority, such as Factory Mutual, Underwriters' Laboratory, or any equipment identification, performance rating, name or nomenclature plates.

c. Cover moving parts and labels during the painting Work with protective masking. Remove all protective masking upon completion of Work. Remove all paint, coatings or splatter which comes in contact with such labels.

9. Structural and miscellaneous metals covered with concrete, shall not receive intermediate or finish coats of paint.

1.2 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Contractor shall submit the name and experience record of the painting subcontractor. Include a list of utility or industrial installations painted, responsible officials, architects, or engineers concerned with the project and the approximate contract price.

2. Painting subcontractors whose submissions indicate that they have not had the experience required to perform the Work shall not be approved. Qualifying experience shall include at least three (3) previous projects of similar magnitude and complexity to this project that have been completed not less than eighteen (18) months prior to submission of qualifications.

3. Contractor shall submit written approval from the Manufacturer verifying that the painting subcontractor is approved to install the Manufacturer's coatings.

B. All materials specified by name, brand or manufacturer shall be delivered unopened to the job in their original containers. The paint

shall be applied in strict accordance with the recommendations of the manufacturer using equipment approved for the duty.

C. Source Quality Control:

1. Provide the services of a qualified Manufacturer's representative at the Project site for a minimum of two (2) trips and two (2) 8 hour work days at the commencement of Work to advise on materials, surface preparation, installation and finishing techniques.

2. Certify long term compatibility of all coatings with all substrates.

3. Certify that products supplied comply with local regulations controlling use of Volatile Organic Compounds (VOCs).

4. Provide the services of a qualified manufacturer's representative at the Project site for a minimum of two (2) trips and two (2) 8 hour work days prior to application of paint to inspect, advise on, and approve surface preparation.

5. Provide the services of a qualified Manufacturer's representative at the Project site for a minimum of two (2) trips and four (4) 8 hour work days during application; and a minimum of two (2) trips and two (2) 8 hour work days at completion of the work to inspect the work.

6. Within seven (7) calendar days after each site visit by the manufacturer, the Contractor shall provide a written report from the manufacturer certifying the surface preparation, installation, and the coatings have been applied properly and in accordance with the manufacturer's recommendations and requirements. Deficiencies in the coatings system, if any, noted by the manufacturer during any of the inspections shall be defined in the manufacturer's report including corrective measures to be implemented by the Contractor at the Contractor's expense. Following corrective measures by the Contractor, the manufacturer shall re-inspect the work, at the Contractor's expense and the Contractor shall, within seven (7) days after re-inspection, provide a written report from the manufacturer certifying the surface preparation and the coatings have been

applied properly and in accordance with the manufacturer's recommendations and requirements.

D. Reference Regulations: Surface preparation and application of coatings shall be performed by the Contractor in compliance with all applicable federal, state and local occupational safety, health and air pollution control regulations. The Contractor shall obtain and comply with all safety precautions recommended by the paint manufacturer in printed instructions or special bulletins, and as required by applicable regulations. The Contractor shall provide forced ventilation in all areas where inadequate ventilation exists.

1.3 SUBMITTALS

A. Submittals shall be provided as specified below. The Contractor shall be required to submit his proposed protective coating systems prior to any other equipment, piping, or hardware submittals that require protective coatings. After review of the protective coating submittals to indicate no further submittals are required, the Contractor shall be required to furnish only the approved protective coatings throughout the project.

B. Shop Drawings: Submit for approval the following:

1. Copies of manufacturer's technical information, including paint label analysis and application instructions for each material proposed for use.

2. Copies of Contractor's proposed protection procedures in each area of the Work.

3. List each material and cross-reference to the specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.

4. Copies of manufacturer's complete color charts for each coating system.

5. Maintenance Manual: Upon completion of the Work, furnish copies of a detailed maintenance manual including the following information:

a. Product name and number.

b. Name, address and telephone number of manufacturer and local distributor.

c. Detailed procedures for routine maintenance and cleaning.

d. Detailed procedures for light repairs such as dents, scratches and staining.

6. Copies of Material Safety Data Sheets.

C. Certificates: Submit for approval the following:

1. Certificate stating that materials meet or exceed Specification requirements.

2. Contractor shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems' components shall have been reviewed by an authorized technical representative of the paint Supplier for use as a compatible system. Verify that all painting systems are acceptable for the exposures specified and that the Supplier is in agreement that the selected systems are proper, compatible arid are not in conflict with the paint Supplier's recommended specifications. Show by copy of transmittal form that a copy of the letter has been transmitted to the paint applicator.

D. Statement of Application: Upon completion of the painting Work, submit a notarized statement to Engineer signed by Contractor and painting applicator stating that the Work complies with the requirements of these Specifications and that application methods, equipment and temperatures were proper and adequate for the conditions of installation and use.

E. Test Reports: Submit for approval certified laboratory test reports for required performance and analysis testing.

1.4 PRODUCT DELIVERY, STORAGE AND HAULING

A. Delivery of Materials: Deliver all materials to the Site in original, new and unopened packages and containers bearing Supplier's name and label, and the following information:

1. Name and title of material.
2. Supplier's stock number and date of manufacture.
3. Supplier's name.
4. Contents by volume, for major pigment and vehicle constituents.
5. Thinning instructions where recommended.
6. Application instructions.
7. Color name and number.

B. Storage of Materials:

1. Store only acceptable painting system components at the Site.
2. Store in an environmentally controlled location as recommended by paint Supplier's written product information guidelines. Keep area clean and accessible.
3. Store materials not in actual use in tightly covered containers.
4. Comply with governing health and fire regulations.

C. Handling of Materials:

1. Handle materials in a manner which precludes the possibility of contamination, or incorrect product catalyzation.
2. Do not open containers or mix components until necessary preparatory Work has been completed and approved by Engineer and painting Work will start immediately.

3. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.

1.5 JOB CONDITIONS

A. Site Facilities:

1. Supplemental heat sources, as may be required to maintain both ambient and surface temperatures within the range recommended by the Supplier for paint system applications, are not available at the Site.

2. The provision of all supplemental heat energy sources and equipment is the responsibility of Contractor.

3. Do not use heat sources which emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent all such heat sources to the exterior such that paint systems are unaffected by exhaust products.

B. Existing Conditions:

1. Before painting is started in any area, all surfaces to be painted and floors shall be cleaned of all dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air filters (HEPA filters) and dust containment systems.

2. After painting operations begin in a given area cleaning shall be done only with commercial vacuum cleaning equipment.

C. Environmental Requirements:

1. Apply water-based paints only when the temperature of surfaces to be painted and the surrounding air temperatures are between 55F and 90°F, unless otherwise permitted or restricted by the paint Supplier's printed instructions.

2. Surfaces to be painted shall be at least 5F above the dew point temperature and shall be dry to the touch. Apply paints only when the temperature of surfaces to be painted, paint material, and the surrounding air temperatures are between 65 OF and 95 OF,

unless otherwise permitted or restricted by the paint Supplier's printed instructions.

3. Apply paint system within the shortest possible time consistent with Supplier's recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, it shall be removed in accordance with SSPC-SP 1 Solvent Cleaning, and the surface restored before applying remainder of painting system.

4. Tanks containing water shall not be painted without specific permission of Engineer, and only under conditions where "sweating" of the tank outside surface is not likely to occur within 24 hours of application.

5. Epoxy paints shall not be applied if ambient temperature is expected to go below 50°F within 12 hours of application. Where Supplier's printed recommendations require a higher minimum ambient temperature, this shall be followed.

6. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during the course of the paint application, unless otherwise permitted by the paint Supplier's printed instructions.

7. Do not paint pipelines and other unacceptably hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to Supplier. Contractor shall arrange for such surfaces to be brought within acceptable temperature and dew point ranges as part of the painting Work.

8. Moisture content of surfaces shall be verified to Engineer as acceptable to permit the commencement of the painting Work using methods recommended by the specified Supplier.

9. Painting 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 Supplier during application and drying periods.

10. Provide adequate illumination and ventilation in all areas where painting operations are in progress.

11. Comply with applicable governing code requirements for air quality and material disposal regulations.

D. Pre-Painting Conference:

1. Prior to the installation of painting systems, Contractor shall arrange a meeting at the Site with painting applicator and its foreman, the paint Supplier's technical representative, the installers of other work in and around the painting system Work which must follow the painting Work, Engineer and other representatives directly concerned with performance of the painting Work. Record the discussions of the conference and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures related to the painting Work, including but not necessarily limited to, the following:

    a. Review project requirements including Drawings, Specifications, approved Shop Drawings, pending and approved Change Orders and requests for information which may have been submitted by Contractor to Engineer.

    b. Review required samples and submittals, both completed and yet to be completed.

    c. Review status of surfaces including drying, surface preparations and similar considerations.

    d. Review availability of materials, tradesman, equipment and facilities needed to make progress, avoid delays and protect the Work from damaging conditions.

    e. Review required inspection, testing, certifying and quality control procedures.

    f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.

Supplemental heating sources, as may be required to continue the Work under low temperature conditions, shall be in operating order and acceptable to paint applicator.

g. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.

2. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

3. Record any revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.

E. Protection:

1. Cover or otherwise protect finished Work of other trades and surfaces not being painted concurrently or not to be painted.

2. During the surface preparation and painting Work, the facility shall remain in operation. Employ procedures which prevent contamination of the process or cause facility shutdown due to the Work of this Section.

3. Coordinate and schedule surface preparation and painting Work to avoid exposing employees of Contractor, Owner, Engineer, and others who are not involved with the surface preparation and painting Work to the Work of this Section. Provide required personnel safety equipment in compliance with governing authorities.
4. Submit protection procedures to be employed by Contractor to Engineer. Do not begin surface preparation and painting Work in any area until Engineer approves protection techniques proposed by Contractor.

5. Provide fire extinguishers and post caution signs warning against smoking and open flame when working with flammable materials.

PART 2 PRODUCTS

2.1 MATERIAL QUALITY

A. Product and Manufacturer: Provide one of the following:

1. Tnemec Company, Incorporated.
2. The Sherwin-Williams Company.
3. The Carboline Company, part of the StonCor Group, An RMP Company.
4. E.I. DuPont de Nemours & Company.
5. Advanced Polymer Sciences, Incorporated.
6. Glidden Company.
7. Benjamin Moore & Company.
8. Devoe.

B. The use of catalog numbers and the specific requirements set forth in the Specifications, are not intended to preclude the use of any other acceptable Supplier's products which may be equivalent, but are given for the purpose of establishing a standard of design and quality of materials, application and workmanship.

C. Where catalog numbers are out of date at time of bidding, provide products equal in quality to those specified.

2.2 SUBSTITUTIONS

A. No substitutions shall be considered that decrease the number of coats, the film thickness, the surface preparation or the generic type, solids content by volume, and formulation of coating(s) specified. Products exceeding VOC limits specified will not be approved.

B. Engineer may review Suppliers' recommendations concerning methods of installation and number of coats of paint for each painting system. Contractor shall prepare construction cost estimates based on painting

systems, number of coats, coverages and installation methods specified.

C. All proposed "or equal" products shall be submitted with direct comparison to products specified including information on durability, adhesion, color and gloss retention, percent solids, VOC's per gallon and recoatability after curing.

D. Approved Suppliers shall furnish the same color selection as the Supplier specified, including intense chroma and custom pigmented colors in all painting systems.

2.3 COLORS AND FINISHES

A. Color Selection:

1. A maximum of 20 different colors shall be selected for the painting Work, in addition to color coding of all pipelines, valves, equipment, ducts and electrical conduit.

2. Engineer reserves the right to select all non-standard colors for all paint systems specified within the ability of the Supplier to produce such non-standard colors. Contractor shall supply such colors at no additional expense to Owner.

B. Color Coding of Pipelines, Valves, Equipment and Ducts:

1. In general, all color coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI Al3.l, ANSI Z535.1 and OSHA 1910.144. Color coding for process piping shall be selected by the Engineer.

2. For equipment located on roofs or where exposed to public view such as on exterior building facades, or in offices or lobbies, the color shall be selected by Engineer.

3. Color Coding of Pipelines and Equipment:

i. Finish coats of paint for pipelines and equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety colors In

accordance with ANSI Z535.1 color specifications for safety colors and other basic colors.

4. The color of the final coats shall match as closely as possible, without custom blending, the color tabulated under the specific pipeline service.

C. After approval by Engineer of colors and Shop Drawing submittals and prior to beginning painting Work, Engineer will furnish color schedules for surfaces to be painted listed in paragraph 2.4, Painting Systems below.

D. Color Pigments: Provide pure, nonfading, applicable types to suit the surfaces and services indicated. Comply with the following:

1. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by Laws and Regulations.

2. Areas subject to hydrogen sulfide fume exposure shall be identified by Engineer. Supplier shall notify Engineer of colors which are not suitable for long-term color retention in such areas.
3. Supplier shall identify colors which meet the requirements of governing standards for use in locations subject to contact with potable water or water being prepared for use as potable water.

4. Comply with Suppliers' recommendations on preventing coating contact with levels. of carbon dioxide and carbon monoxide which could cause yellowing during application and initial stages of curing of paint coatings.

2.4 PAINTING SYSTEMS

A. Ferrous metals, interior and exterior, non-submerged including piping, structural steel and miscellaneous steel.

1. Surface Preparation: SSPC-SP6 Commercial Blast.

2. Shop Primer:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66-1211 H.B. Epoxoline, 3.0-5.0 dry mils.

2) Sherwin Williams: Copoxy Shop Primer, 3.0-5.0 dry mils.

3) Carboline: Carboguard 893$G. 3.0-5.0 dry mils.

4) Or equal.

3. Field Preparation: SSPC-SP11 Power Tool Cleaning.

4. Field Spot Intermediate:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66-Color H.B. Epoxoline 4.0-6.0 dry mils.

2) Sherwin Williams: Epolon II multi mill epoxy 4.0-6.0 dry mils.

3) Carboline: Carboguard 893SG. 4.0-6.0 dry mils.

4) Or equal.

5. Finish Coat Interior:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66-Color H.B. Epoxoline 8.0-12.0 dry mils.

2) Sherwin Williams: Tile-Clad High Solids 8.0-12.0 dry mils.

3) Carboline: Carboguard 893SG. 8.0-10.0 dry mils.

4) Or equal.

6. Finish Coat Exterior:

    a. Generic Description: Aliphatic Acrylic Polyurethane.

    b. Product and Manufacturer:

        1) Tnemec:

            a) Gloss-Endura-Shield 74, 2.0-3.0 dry mils.

            b) Semi Gloss-Endura-Shield 75, 2.0-3.0 dry mils.

        2) Sherwin Williams:

            a) Gloss-Hi Solids Polyurethane, 2.0-3.0 dry mils.

            b) Semi Gloss-Corothanell, 2.0-3.0 dry mils.

        3) Carboline:

            a) Carbothane 133HB, 2.0-3.0 dry mils.
            b) Carbothane 134HG, 2.0-3.0 dry mils.

        4) Or equal.

B. Galvanized, Aluminum and Non-Ferrous Metals (non-submerged):

    1. Surface Preparation: SSPC-SP3 Power Tool Clean.

    2. Shop Primer:

        a. Generic Description: Polyamide Epoxy.

        b. Product and Manufacturer:

            1) Tnemec: 66 H.B. Epoxoline, 2.0-3.0 dry mils.

            2) Sherwin Williams: Macropoxy 646, 2.0-3.0 dry mils.

            3) Carboline: Carboguard 893SG. 2.0-3.0 dry mils.

            4) Or equal.

3. Field Preparation: SSPC-SP-3 Power Tool Clean.

4. Finish Coat Interior:

    a. Generic Description: Polyamide Epoxy.

    b. Product and Manufacturer:

        1) Tnemec: 66 H.B. Epoxoline, 2.0-4.0 dry mils.

        2) Sherwin Williams: Tile Clad High Solids Epoxy, 2.0-4.0 dry mils.

        3) Carboline: Carboguard 893SG. 2.0-4.0 dry mils.

        4) Or equal.

5. Finish Coat Exterior:

    a. Generic Description: Aliphatic Acrylic Polyurethane.

    b. Product and Manufacturer:
        1) Tnemec: Semi-Gloss-74 Endura-Shield, 2.0-4.0 dry mils.

        2) Sherwin Williams: Semi Gloss-Corothan II, 2.0-4.0 dry mils.

        3) Carboline: Carbothane 133HB, 2.0-4.0 dry mils.

        4) Or equal.

C. Ferrous metals, interior or exterior, submerged or intermittently submerged:

1. Surface Preparation: SSPC-SPI, SSPC-SP2, SSPC-SP3, as recommended by manufacturer. If existing paint system is found not compatible with the specified system, it shall be removed per SSPC-SP10.

2. Primer:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66 H.B. Epoxoline, 3.0-5.0 dry mils.

2) Sherwin Williams: Hi Solids Catalyzed Epoxy B62, 3.0-5.0 dry mils.

3) Carboline: Carboguard 893SG. 3.0-5.0 dry mils.

4) Or equal.

3. Field Spot Intermediate:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66 H.B. Epoxoline, 3.0-5.0 dry mils.
2) Sherwin Williams: Hi Solids Catalyzed Epoxy B62, 3.0-5.0 dry mils.

3) Carboline: Carboguard 893SG. 3.0-5.0 dry mils.

4) Or equal.

4. Finish Coat:

a. Generic Description: Amine-catalyzed epoxy.

b. Product and Manufacturer:

1) Tnemec: 104 H.S. Epoxy, 1 coat, 4.0 to 6.0 dry mils.

2) Sherwin Williams: Macropoxy B58 Series, 1 coat 4.0 to 6.0 dry mils.

3) Carboline: Carboguard 890, 1 coat 4.0-6.0 dry mils.

4) Or equal.

D. Galvanized, Aluminum and Non-Ferrous Metals (Submerged or intermittently submerged:

1. Surface Preparation: SSPC-SP3 Power Tool Clean.

2. Shop Primer:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 69 H.B. Epoxoline, 2.0-3.0 dry mils.

2) Sherwin Williams: Hi Solids Catalyzed Epoxy, 2.0-3.0 dry mils.
3) Carboline: Carboguard 890, 2.0-3.0 dry mils.

4) Or equal.

3. Field Preparation: SSPC-SP-3 Power Tool Clean.

4. Finish Coat Interior:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 69 H.B. Epoxoline, 2.0-4.0 dry mils.

2) Sherwin Williams: Hi Solids Catalyzed Epoxy, 2.0-4.0 dry mils.

3) Carboline: Carboguard 890, 2.0-4.0 dry mils.

4) Or equal.

5. Finish Coat Exterior:

a. Generic Description: Aliphatic Acrylic Polyurethane.

b. Product and Manufacturer:

1) Tnemec: Semi-Gloss-74 Endura-Shield, 2.0-4.0 dry mils.

2) Sherwin Williams: Semi Gloss-Corothane II, 2.0-4.0 dry mils.

3) Carboline: Carbothane 133HB, 2.0-4.0 dry mils.

4) Or equal.

E. Aluminum in Contact with Dissimilar Materials:

1. Surface Preparation: Solvent clean.

2. Shop Prime:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66 Hi-Build Epoxoline, 2.0-3.0 dry mils.

2) Sherwin Williams: Macropoxy 646, 2.0-3.0 dry mils.

3) Carboline: Carboguard 893G. 2.0-3.0 dry mils.

4) Or equal.

3. Finish Coat:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66 Hi-Build Epoxoline, 2.0-3.0 dry mils.

2) Sherwin Williams: Macropoxy 646, 2.0-3.0 dry mils.

3) Carboline: Carboguard 893SG. 2.0-3.0 dry mils.

4) Or equal.

F. Interior Concrete Masonry:

1. Surface Preparation: Allow 28 days to cure, remove all spatter and nibs.

2. Primer:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 54-660 Masonry Filler, 10 dry mils.

2) Sherwin Williams: Kem Cati-Coat Epoxy Filler, 10 dry mils.

3) Carboline: Sanitile 600, 10-12 dry mils.

4) Or equal.

3. Finish Coat:

a. Generic Description: Polyamide Epoxy.

b. Product and Manufacturer:

1) Tnemec: 66 H.B. Epoxoline, 4.0-6.0 dry mils.

2) Sherwin Williams: Tile Clad High Solids Epoxy, 6.0-10.0 dry mils.

3) Carboline: Carboguard 893$G. 4.0-6.0 dry mils.

4) Or equal.

G. PVC Piping, CPVC Piping, Fiberglass, Fiberglass Insulation Covering.

1. Surface Preparation: Sand as specified in 3.2.G.

2. Product and Manufacturer: Provide one of the following:

a. Tnemec:

1) Finish: 69 H.B. Epoxoline II- 2 coats, 2.0-3.0 dry mils per coat, 240-360 square feet per gallon per coat.

b. Sherwin Williams:

1) Finish: Macropoxy 646-2 coats, 2.0-3.0 dry mils per coat, 400-600 square feet per gallon per coat.

c. Finish: Carboline Carboguard 890, 2.0-3.0 dry mils per coat.

d. Or equal.

H. Wood:

1. Surface Preparation: Sand and clean.

2. Primer:

a. Generic Description: Acrylic Emulsion.

b. Product and Manufacturer:

1) Tnemec: 51-792 PVA Sealer, 1.0-2.0 dry mils.

2) Sherwin Williams: PrepRite 200 Latex Wall primer, 1.0-2.0 dry mils.

3) Carboline: Sanitile 120, 1.0-2.0 dry mils.

4) Or equal.

3. Intermediate:

    a. Generic Description: Waterborne Acrylic Epoxy.

    b. Product and Manufacturer:

        1) Tnemec: 113/114 Tuff Coat, 3.0-5.0 dry mils.

        2) Sherwin Williams: Epo-plex multi-mil, 3.0-5.0 dry mils.

        3) Carboline: Sanitile 255, 2.0-3.0 dry mils.

        4) Or equal.

4. Finish Coat:

    a. Generic Description: Waterborne acrylic epoxy.

    b. Product and Manufacturer:

        1) Tnemec: 113/114 Tuff Coat, 3.0-5.0 dry mils.

        2) Sherwin Williams: Epo-plex multi-mil, 3.0-5.0 dry mils.

        3) Carboline: Sanitile 255, 2.0-3.0 dry mils.

        4) Or equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Contractor and his applicator shall examine the areas and conditions under which painting Work is to be performed and notify Engineer in writing of conditions detrimental to the proper and timely completion of

the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film capable of performing in accordance with claims made in Supplier's product literature for the surfaces and conditions encountered.

C. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for the long-term adherence and durability of painting systems specified or where the Supplier requires removal of all existing paint in order to recommend the use of the specified painting system.

3.2 SURFACE PREPARATION

A. General:

1. Test for moisture content of surfaces before commencement of painting Work. Test for moisture in concrete in compliance with ASTM D 4263. Report results to Engineer before commencing Work.

2. Prepare existing surfaces required to be painted as specified for new surfaces. Where Contractor proposes other methods of preparing existing surfaces they shall be submitted to Engineer for approval at time of Shop Drawing submittal. Engineer's approval of alternative surface preparation methods shall not relieve Contractor of performance required under this Section.

3. Perform all preparation and cleaning procedures as specified herein and in strict accordance with paint Supplier's instructions for each particular surface and atmospheric condition.

4. Contractor shall remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in-place and that do not require field-painting, or provide effective surface-applied protection prior to surface preparation and painting operations.

5. Contractor shall remove, as necessary, items which must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved.

6. Clean surfaces to be painted before applying any painting system components. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.

7. Prepare all surfaces which were improperly shop-painted, and all abraded or rusted shop-painted surfaces, as specified.

B. Ferrous Metals:

1. Comply with Supplier's recommendations for type and size of abrasive in order to provide a surface profile that meets the Supplier's painting system requirements for type, function and location of surface. Verify that Supplier recommended profiles have been achieved on prepared surfaces. Report profiles to Engineer using Test Method C in compliance with ASTM D 4417.

2. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale and all other contamination by commercial blast cleaning complying with SSPC-SP6, at the time of paint system application, using SSPC VIS 1 as a standard of comparison.

3. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale and all other contamination by near-white blasting complying with SSPC-SPlO, at the time of painting system application, using SSPC VIS 1 as a standard of comparison.

4. Clean non-submerged, ferrous surfaces that have not been shop- coated of all oil, grease, dirt, loose mill scale and and other contamination by commercial blasting complying with SSPC-SP6, at the time of painting system application, using SSPC VIS 1 as a standard of comparison.

5. Clean submerged ferrous surfaces that have not been shop-coated or that have been improperly shop-coated, of all oil, grease, dirt, mill scale and all other contamination by near-white blasting complying with SSPC-SP1O, at the time of painting system application, using SSPC VIS 1 as a standard of comparison.

6. Touch-up shop-applied prime coats which have damaged or have bare areas, with primer recommended by Supplier after commercial blasting complying with SSPC-SP6, at the time of painting system application, using SSPC VIS 1 as a standard of comparison, to provide a surface profile of not less than 1 mil.

7. Power tool clean, complying with SSPC-SP3, in order to remove welding splatter and slag.

8. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool cleaning complying with SSPC SPl 1 to provide a surface profile of not less than 1 mil.

C. Non-Ferrous Metal Surfaces: Prepare all non-ferrous metal surfaces for painting by light whip-blasting or by lightly sanding with 60-80 mesh sandpaper.

D. Galvanized (Zinc-Coated) Surfaces: Prepare all galvanized surfaces for painting by lightly sanding with 60-80 mesh sandpaper or by light whipblasting.

E. Masonry Surfaces:

1. Prepare surfaces of concrete unit masonry to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and other contamination, with soap and water. All surfaces shall be clean and dry at the time of paint system application.

2. Concrete unit masonry that cannot be adequately cleaned by soap and water shall be acid etched with a commercial solution of 15 percent muriatic acid.

3. Prepare and clean all surfaces of cast-in-place concrete and precast concrete in compliance with ASTM D4259 to obtain a uniform and continuous anchor profile of approximately 1 mil. Provide mechanical abrading procedures and abrasive blasting procedures as specified in ASTM D4259. Use 40 to 80 mesh abrasive and clean, dry, compressed air. Compressed air cleanliness shall be in compliance with ASTM D4285. Pressure at blasting nozzle shall not exceed 80 psi. Do not concentrate blast on surface but move at a fairly rapid rate to provide a surface free of laitance and contaminants. Provide post-surface preparation cleaning in accordance with ASTM D4258 to remove loose material. Surface preparation shall open all surface air holes by removing all laitance shoulders surrounding the air holes. Vacuum all surfaces to remove all dust and sand and wash with potable water.

4. Where paint system is used to provide chemical containment barrier protection, repair cracks and expansion joints in concrete and provide 2-inch radiused cove base fillets at all equipment pads and containment walls as part of the complete chemical containment paint system Work. Use materials and techniques recommended by the specified Manufacturer.

5. Remove all cast-in-place concrete fins, projections and other surface irregularities which would protrude above the level of finished intermediate fillers and surfacers by chipping and scarification by mechanical abrasion.

6. Using specified filler and surfacer, patch all cast-in-place concrete and precast concrete surfaces as required to completely fill surface air holes and honeycombing. Level all protrusions and grind filler and surfacing compounds smooth and level with adjacent surfaces.

7. Perform tests in compliance with ASTM D4262 and ASTM D4263 in order to verify the alkalinity and moisture content of the surfaces to be painted and report 'findings to Engineer. If, in

the opinion of Engineer, the surfaces are sufficiently alkaline to cause blistering and burning of the paint, correct this condition before application of paint. Provide suitable testing materials in order to carry out alkalinity and moisture tests. Do not paint over surfaces where the moisture content exceeds 8 percent.

8. Where a concrete unit masonry block filler is specified, spot patch holes and cracks with a putty knife using specified block filler. Apply to large surfaces by airless spray and backroll uniformly using a roller with a synthetic nap cover. Follow with a rubber squeegee in order to provide a smooth finish.

3.3 MATERIALS PREPARATION

A. General:

1. Mix and prepare painting materials in strict accordance with Supplier's product literature.

2. Do not mix painting materials produced by different Suppliers unless otherwise permitted by Supplier's instructions.

3. Where thinners are required in the Work, they shall be produced by the paint system Supplier, unless otherwise permitted by the Supplier's product literature, submitted to Engineer at the time of Shop Drawing approval.

B. Tinting:

1. Tint each undercoat a lighter shade to facilitate identification of each coat of paint where multiple coats of the same material are to be applied.

2. Tint undercoats to match the color of the finish coat of paint, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by the Supplier.

C. Mixing:

1. For those products requiring constant agitation use methods in compliance with Supplier's product literature, to prevent settling during paint application.

2. Mix only in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect concrete floors from slashes or spills which could stain exposed concrete or react with subsequent finish floor material.

3. Mix and apply paint only in containers bearing accurate product name of material being mixed, or applied.

4. Stir all materials before application to produce a mixture of uniform density, and as required during the application of the materials. Do not stir any film which may form on the surface into the material. Remove the film and, if necessary, strain the material before using.

5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50 mesh screen before application.

3.4 APPLICATION

A. General:

1. Apply paint systems by brush, roller, or airless spray in accordance with Supplier's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Vol. 2, where applicable. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high pile sheep wool as recommended by Supplier for material and texture required. Use air spray and airless spray equipment recommended by Supplier for specific painting systems specified. Submit a list of application methods proposed, listing paint systems and location.

2. Paint dry film thicknesses required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried.

3. Apply additional coats when undercoats, stains, or other conditions show through. the final coat of paint, until the paint film is of uniform finish, color and appearance. This is of particular importance regarding intense chroma primary colors. Insure that all surfaces, including edges, comers, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.

4. Surfaces of items not normally exposed-to-view do not require the same color as other components of the system of which they are a part, but require the same painting system specified for exposed surfaces of the system.

    a. "Exposed-to-view surfaces" is defined as those areas visible when permanent or built-in fixtures, convector covers, ceiling tile, covers for finned tube radiation, grilles, etc. are in-place in areas scheduled to be painted.

5. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.

6. Paint the backs of access panels, and removable or hinged covers, to match the exposed surfaces.

7. Paint aluminum parts in contact with dissimilar materials with specified paint system.

8. Omit field-primer on metal surfaces which have been shop-primed. Touch-up paint shop-primed coats and pre-finished items only when approved by Engineer using compatible primers and Supplier's recommended compatible field-applied finishes.
9. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

B. Minimum/Maximum Paint Film Thickness:

1. Apply each material at not less than, nor more than, Supplier's recommended spreading rate, and provide total dry film thickness as specified.

2. Apply additional coats of paint if required to obtain specified total dry film thickness.

3. Maximum dry film thickness shall not exceed twice the minimum dry film thickness, except where more stringent limitations are recommended by the paint Supplier for a specific product.

C. Scheduling Surface Preparation and Painting:

1. Apply the first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration in consideration of the atmospheric conditions existing at the time of surface preparation and painting. Surfaces that have started to rust before first-coat application is complete shall be brought back to required standard by abrasive blasting.

2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

3. Scarify primers and other painting system components by brush-blasting if paint has been exposed for lengths of time or under conditions beyond Supplier's written recommendations for the painting systems involved, the intended use, or the method of application proposed for subsequent coats of paint.
4. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no bum-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application:

1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. Neatly draw all glass and color break lines.

2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

G. Mechanical Applicators:

1. Use mechanical methods for paint application when permitted by governing ordinances, Supplier, and approved by Engineer.

2. Limit roller applications, if approved by Engineer, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.

3. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two coats in one pass.

H. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by Engineer.

3.5 PROTECTION

A. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove all temporary protective wrappings provided for protection of this Work.

3.6 ADJUSTMENT AND CLEAN-UP

A. Correct all damages to the work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.

B. During the progress of the Work, remove from the Site all discarded paint materials, rubbish, cans and rags at the end of each work day.

C. Upon completion of painting, clean all paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

D. At the completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by Engineer.

+ + END OF SECTION + +

SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. Electrical rooms.
   2. Unit heaters.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRICAL ROOMS

A. On room temperatures above 80 degrees F (27 degrees C) open intake damper and start exhaust fan.

3.02 UNIT HEATERS

A. Single temperature room thermostat set at 60 degrees F (16 degrees C) maintains constant space temperature by cycling unit fan motor and energizing electric heating elements.

END OF SECTION

SECTION 23 34 13 - AXIAL HVAC FANS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.02 SUBMITTALS

A. Product Data: Provide data on axial fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

B. Shop Drawings: Indicate assembly of axial fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

1.03 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide fixed sheaves required for final air balance.

C. Provide safety screen where inlet or outlet is exposed.

D. Provide backdraft dampers on discharge of exhaust fans and as indicated.

END OF SECTION

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers:
   1. Combination louvers.

1.02 SUBMITTALS

A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.01 LOUVERS

A. Type: 6 inch (150 mm) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over intake or exhaust end.

B. Mounting: Furnish with exterior angle flange for installation.

C. Control: Furnish with 120V motorized actuator to control damper blades.

2.02 COMBINATION LOUVERS

A. Damper-combined, drainable louver:

B. Size: As indicated on the drawings.

C. Sleeve or Flange: Factory-mounted standard.

D. Mounting: Furnish with exterior angle flange for installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 23 82 00 - CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electric unit heaters.

1.02 RELATED REQUIREMENTS

A. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.03 SUBMITTALS

A. Product Data: Provide typical catalog of information including arrangements.

B. Shop Drawings:
   1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
   2. Indicate mechanical and electrical service locations and requirements.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

D. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 ELECTRIC UNIT HEATERS

A. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.

B. Assembly: Suitable for mounting from ceiling or structure above with built-in controls, thermal safety cut-out, and electric terminal box.

C. Acceptable Heating Element Assemblies:
   1. Horizontal Projection Units:
      a. Steel fins copper brazed to steel sheath and epoxy sealed for moisture resistance.
      b. Nickel chromium resistance wire surrounded with magnesium oxide and sheathed in steel, spiral-finned tubes.
      c. High-mass, all steel tubular type, copper brazed, centrally located and installed in fixed element banks.

D. Housing:
   1. Horizontal Projection Units:
      a. Construction materials to consist of heavy gauge steel with galvanized, polyester powder coat, or high gloss baked enamel finish.
      b. Provide with threaded holes for threaded rod suspension.
      c. Provisions for access to internal components for maintenance, adjustments, and repair.

E. Air Inlets and Outlets:
   1. Inlets: Provide stamped louvers or protective grilles with fan blade guard.
   2. Outlets: Provide diffuser cones, directional louvers, or radial diffusers.

F. Fan: Factory balanced, direct drive, axial type with fan guard.

G. Motor: Totally enclosed, thermally protected, and provided with permanently lubricated bearings.

H. Controls:
   1. 120-volt control.
   2. Terminal block for remote control.

I. Electrical Characteristics:
   1. Disconnect Switch: Factory mount disconnect switch.
   2. As specified on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Unit Heaters:
   1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
   2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

3.02 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.

B. Vacuum clean coils and inside of units.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Variable-frequency drive cable.

C. Wiring connectors.

D. Electrical tape.

E. Heat shrink tubing.

F. Wire pulling lubricant.

G. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination UNILAY-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

H. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. NFPA 79 - Electrical Standard for Industrial Machinery; 2018.

L. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

N. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

R. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

B. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

H. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

I. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.

J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

K. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
3. Color Code:
a. 480Y/277 V, 3 Phase, 4 Wire System:
1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral/Grounded: Gray.
b. 208Y/120 V, 3 Phase, 4 Wire System:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.
c. Equipment Ground, All Systems: Green.
d. For control circuits, comply with manufacturer's recommended color code.

2.02 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
a. Size 10 AWG and Smaller: Solid.
b. Size 8 AWG and Larger: Stranded.
2. Control Circuits: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
a. Size 4 AWG and Larger: Type XHHW-2.
b. Installed Underground: Type XHHW-2.

2.03 VARIABLE-FREQUENCY DRIVE CABLE

A. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

B. Conductor Stranding: Stranded.

C. Insulation Voltage Rating: 1000 V.

D. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.

E. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.

F. Provide metallic shielding.

G. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   5. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
   6. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

F. Mechanical Connectors: Provide bolted type or set-screw type.

G. Compression Connectors: Provide circumferential type or hex type crimp configuration.

H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.05 ACCESSORIES

A. Electrical Tape:
   1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
   4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
   5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil (0.18 mm); suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
2. Pull all conductors and cables together into raceway at same time.
3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent

support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

G. Terminate cables using suitable fittings.

H. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

I. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

J. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

M. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
      b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
   3. Wet Locations: Use heat shrink tubing.

O. Insulate ends of spare conductors using vinyl insulating electrical tape.

P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Q. Identify conductors and cables in accordance with Section 26 05 53.

R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for services and feeders. The resistance test for parallel conductors listed as optional is not required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground rod electrodes.

E. Ground access wells.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

B. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

E. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Concrete-Encased Electrode:
      a. Provide connection to concrete-encased electrode consisting of not less than 20 feet (6.0 m) of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
   3. Ground Rod Electrode(s):
      a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
      b. Space electrodes not less than 10 feet (3.0 m) from each other and any other ground electrode.
      c. Where location is not indicated, locate electrode(s) at least 5 feet (1.5 m) outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
      d. Provide ground access well for first connected electrode.
   4. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
   5. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.

F. Service-Supplied System Grounding:
   1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
   2. Provide grounding electrode conductor to connect derived system grounded conductor to common grounding electrode conductor ground riser. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

3. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
4. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

H. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
a. Exceptions:
1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gauge of specified conductors.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
a. Exceptions:
1) Use mechanical connectors for connections to electrodes at ground access wells.
3. Unless otherwise indicated, use mechanical connectors or compression connectors for accessible connections.

D. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.

E. Ground Access Wells:

1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches (200 mm) in diameter.
   b. Rectangular Wells: Not less than 12 by 12 inches (300 by 300 mm).
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches (250 mm).
4. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as indicated.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches (150 mm) below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches (100 mm) of top of rod exposed.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

B. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

C. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

D. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachments to concrete surfaces until concrete has fully cured.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems and post-installed concrete and masonry anchors.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch (2.66 mm).
   4. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch (13 mm) diameter.
      b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch (6 mm) diameter.
      c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch (10 mm) diameter.
      d. Trapeze Support for Multiple Conduits: 3/8 inch (10 mm) diameter.

e. Outlet Boxes: 1/4 inch (6 mm) diameter.
f. Luminaires: 1/4 inch (6 mm) diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
a. Comply with MFMA-4.
b. Channel Material: Use galvanized steel or stainless steel.
c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
6. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
3. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

G. Conduit Support and Attachment: Also comply with Section 26 05 33.13.

H. Box Support and Attachment: Also comply with Section 26 05 33.16.

I. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.

J. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.

K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

L. Secure fasteners according to manufacturer's recommended torque settings.

M. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. PVC-coated galvanized steel rigid metal conduit (RMC).

C. Liquidtight flexible metal conduit (LFMC).

D. Rigid polyvinyl chloride (PVC) conduit.

E. Conduit fittings.

F. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

D. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.

E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

F. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005 (Reaffirmed 2013).

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2016.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

K. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

M. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

B. Project Record Documents: Record actual routing for conduits installed underground and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows or PVC-coated galvanized steel rigid metal conduit elbows for bends.
6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches (100 mm) on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit.

F. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

G. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit.

H. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

I. Exposed, Exterior: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

J. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit or PVC-coated galvanized steel rigid metal conduit.

K. Connections to Vibrating Equipment:
1. Dry Locations: Use liquidtight flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
a. Transformers.

2.02 CONDUIT REQUIREMENTS

A. Electrical Service Conduits: Also comply with Section 26 21 00.

B. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:
1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Control Circuits: 1/2 inch (16 mm) trade size.
4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
5. Underground, Interior: 3/4 inch (21 mm) trade size.
6. Underground, Exterior: 1 inch (27 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
3. Material: Use steel or malleable iron.
a. Do not use die cast zinc fittings.
4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil (1.02 mm).

C. PVC-Coated Fittings:
   1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
   2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
   3. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
   4. Material: Use steel or malleable iron.
   5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil (1.02 mm).

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil (0.38 mm).

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
      a. Do not use die cast zinc fittings.

2.06 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.07 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil (0.51 mm).

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

F. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
   4. Unless otherwise approved, do not route conduits exposed:
      a. Across floors.
      b. Across building exterior surfaces.
   5. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   6. Arrange conduit to maintain adequate headroom, clearances, and access.
   7. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
   8. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
   9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
   10. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
   11. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:
      a. Heaters.
   12. Group parallel conduits in the same area together on a common rack.

G. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Use conduit strap to support single surface-mounted conduit.
      a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
   4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
   5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
   6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   7. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
   8. Use of spring steel conduit clips for support of conduits is not permitted.
   9. Use of wire for support of conduits is not permitted.

10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

H. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
   3. Use suitable adapters where required to transition from one type of conduit to another.
   4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
   6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
   7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
   8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

I. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Conceal bends for conduit risers emerging above ground.
   5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
   6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
   7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

J. Underground Installation:
   1. Minimum Cover, Unless Otherwise Indicated or Required:
      a. Underground, Exterior: 24 inches (610 mm).
      b. Under Slab on Grade: 12 inches (300 mm) to bottom of slab.
   2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
   3. Where conduits are subject to earth movement by settlement or frost.

M. Provide grounding and bonding in accordance with Section 26 05 26.

3.03 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

C. Boxes for hazardous (classified) locations.

D. Underground boxes/enclosures.

1.02 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 27 26 - Wiring Devices:
   1. Wall plates.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. SCTE 77 - Specification for Underground Enclosure Integrity; 2017.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 508A - Industrial Control Panels; 2013.

K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. Keys for Lockable Enclosures: Two of each different key.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.
4. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
5. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.

6. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
7. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
8. Minimum Box Size, Unless Otherwise Indicated:
    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
    b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
    c. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
9. Wall Plates: Comply with Section 26 27 26.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
    a. Indoor Clean, Dry Locations: Type 1, painted steel.
    b. Outdoor Locations: Type 4X, stainless steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
    b. Boxes 6 square feet (0.56 sq. m) and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
    a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
    b. Back Panels: Painted steel, removable.
    c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.

E. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches (300 mm).
4. Applications:
    a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
    b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
    c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
5. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
    a. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

E. Box Locations:
   1. Unless dimensioned, box locations indicated are approximate.
   2. Locate boxes as required for devices installed under other sections or by others.
   3. Locate boxes so that wall plates do not cross masonry joints.
   4. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   5. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.

F. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

G. Install boxes plumb and level.

H. Floor-Mounted Cabinets: Mount on properly sized 3 inch (80 mm) high concrete pad.

I. Install boxes as required to preserve insulation integrity.

J. Underground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches (150 mm) deep.
   2. Flush-mount enclosures located in concrete or paved areas.
   3. Mount enclosures located in landscaped areas with top at 1 inch (25 mm) above finished grade.
   4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

K. Close unused box openings.

L. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

M. Provide grounding and bonding in accordance with Section 26 05 26.

N. Identify boxes in accordance with Section 26 05 53.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

G. Warning signs and labels.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

B. Section 26 05 73 - Power System Studies: Arc flash hazard warning labels.

C. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

1.03 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Panelboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Transformers:
1) Identify kVA rating.
2) Identify voltage and phase for primary and secondary.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

c. Enclosed switches, circuit breakers, and motor controllers:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

d. Enclosed Contactors:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

e. Transfer Switches:
1) Identify voltage and phase.
2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.
4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.

3. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

5. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.

6. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances.
a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches (76 mm) wide.

7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
a. Service equipment.
b. Industrial control panels.

c. VFD's.
8. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. At each source and load connection.
b. Within boxes when more than one circuit is present.
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

C. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet (6.1 m).
2. Use underground warning tape to identify underground raceways.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.

E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
2. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
3. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Materials:
a. Indoor Clean, Dry Locations: Use plastic nameplates.
b. Outdoor Locations: Use stainless steel or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.
a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
a. Use only for indoor locations.

2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend:
a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
a. System Designation: 1 inch (25 mm).
b. Equipment Designation: 1/2 inch (13 mm).
c. Other Information: 1/4 inch (6 mm).
5. Color:
a. Normal Power System: White text on black background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch (6 mm).
5. Color: Black text on white background unless otherwise indicated.

E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches (51 mm) by 4 inches (100 mm).
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch (13 mm).
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

G. Format for Control Device Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch (5 mm).
5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
1. Do not use handwritten text.

E. Minimum Text Height: 1/8 inch (3 mm).

F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   4. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

D. Legend:
   1. Markers for Voltage Identification: Highest voltage present.

E. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 3 inches (76 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
   1. Tape for Buried Power Lines: Black text on red background.

2.06 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches (76 mm) wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
      a. Do not use labels designed to be completed using handwritten text.
   2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
   3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   3. Elevated Equipment: Legible from the floor or working platform.
   4. Branch Devices: Adjacent to device.
   5. Interior Components: Legible from the point of access.
   6. Conduits: Legible from the floor.
   7. Boxes: Outside face of cover.
   8. Conductors and Cables: Legible from the point of access.
   9. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
   1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches (75 mm) below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Short-circuit study.

B. Protective device coordination study.

C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.

D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.

1.03 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants; 1993 (Reaffirmed 1999).

C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata (2003).

D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.

F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations; 2018, with Errata (2019).

G. NEMA MG 1 - Motors and Generators; 2017.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Engineer.

1.05 SUBMITTALS

A. Study reports, stamped or sealed and signed by study preparer.
   1. Provide report in PDF format, including printable copies of arc flash labels.
   2. Provide all applicable study software source data files.

B. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

C. Project Record Documents: Revise studies as required to reflect as-built conditions.

1. Include hard copies with operation and maintenance data submittals.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system as indicated on drawings.
   2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
   3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
      a. Known Operating Modes:
         1) Utility as source.
         2) Generator as source.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
         2) Utility Company: Duke Energy.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      e. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
         2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
      f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
      g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
   1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
   2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
      a. Maximum utility fault currents.
      b. Maximum motor contribution.

c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
a. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
a. Maximum and minimum utility fault currents.
b. Maximum and minimum motor contribution.
c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
a. Identify date of study and study preparer.
b. Identify study methodology and software product(s) used.
c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
d. Identify base used for per unit values.
e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
f. Include conclusions and recommendations.
2. Short-Circuit Study:
a. For each scenario, identify at each bus location:
1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
2) Fault point X/R ratio.
3) Associated equipment short circuit current ratings.
b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
b. For each graph include (where applicable):
1) Partial single-line diagram identifying the portion of the system illustrated.

2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
3) Conductors: Damage curves.
4) Transformers: Inrush points and damage curves.
5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
6) Motors: Full load current, starting curves, and damage curves.
7) Capacitors: Full load current and damage curves.

c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
2) Include ground fault pickup and delay.
3) Include fuse ratings.
4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:
a. For the worst case for each scenario, identify at each bus location:
1) Calculated incident energy and associated working distance.
2) Calculated arc flash boundary.
3) Bolted fault current.
4) Arcing fault current.
5) Clearing time.
6) Arc gap distance.

b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.07 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years of experience in the preparation of studies of similar type and complexity using specified computer software.
1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
2. Study preparer may be employed by field testing agency.
3. Study preparer may be the electrical engineer of record for the project design.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
1. Acceptable Software Products:
a. EasyPower LLC: www.easypower.com/#sle.
b. ETAP/Operation Technology, Inc: www.etap.com/#sle.
c. SKM Systems Analysis, Inc: www.skm.com/#sle.

PART 2 PRODUCTS

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
1. Materials: Comply with Section 26 05 53.
2. Minimum Size: 4 by 6 inches (100 by 150 mm).

3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
    a. Include orange header that reads "WARNING" unless otherwise indicated.
    b. Include the following information:
        1) Arc flash boundary.
        2) Available incident energy and corresponding working distance.
        3) Nominal system voltage.
        4) Date calculations were performed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 05 53.

3.02 FIELD QUALITY CONTROL

A. Adjust equipment and protective devices for compliance with studies and recommended settings.

B. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.

END OF SECTION

SECTION 26 05 83 - WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

B. Section 26 05 33.13 - Conduit for Electrical Systems.

C. Section 26 05 33.16 - Boxes for Electrical Systems.

D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MATERIALS

A. Wiring Devices: As specified in Section 26 27 26.

B. Flexible Conduit: As specified in Section 26 05 33.13.

C. Wire and Cable: As specified in Section 26 05 19.

D. Boxes: As specified in Section 26 05 33.16.

2.02 EQUIPMENT CONNECTIONS

A. Electrical requirements shown on drawings.

PART 3 EXECUTION

3.01 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outdoor photo controls.

B. Lighting contactors.

C. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

I. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

J. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

B. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 OUTDOOR PHOTO CONTROLS

A. Stem-Mounted Outdoor Photo Controls:
   1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
   2. Housing: Weatherproof, impact resistant polycarbonate.
   3. Photo Sensor: Cadmium sulfide.
   4. Provide external sliding shield for field adjustment of light level activation.
   5. Light Level Activation: 1 to 5 footcandles (10.8 to 53.8 lux) turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
   6. Voltage: As required to control the load indicated on the drawings.
   7. Failure Mode: Fails to the on position.
   8. Load Rating: As required to control the load indicated on the drawings.
   9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

2.03 LIGHTING CONTACTORS

A. Description: Magnetic lighting contactors complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; noncombination type unless otherwise indicated; ratings, configurations and features as indicated on the drawings.

B. Short Circuit Current Rating:
   1. Provide contactors with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

C. Enclosures:
   1. Comply with NEMA ICS 6.
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   3. Finish: Manufacturer's standard unless otherwise indicated.

2.04 ACCESSORIES

A. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Nominal Size: 30 mm.
   3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   5. Indicating Lights: Push-to-test type unless otherwise indicated.
   6. Provide LED lamp source for indicating lights and illuminated devices.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of lighting control devices provided under this section.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.

G. Provide required supports in accordance with Section 26 05 29.

H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Identify lighting control devices in accordance with Section 26 05 53.

J. Outdoor Photo Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

3.03 FIELD QUALITY CONTROL

A. Inspect each lighting control device for damage and defects.

B. Test outdoor photo controls to verify proper operation, including time delays where applicable.

C. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.04 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Engineer.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of lighting control devices to Engineer, and correct deficiencies or make adjustments as directed.

END OF SECTION

SECTION 26 21 00 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 36 00 - Transfer Switches: Service entrance equipment.

1.03 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.04 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; 2017.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of contract award, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Owner.

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:
   1. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.06 SUBMITTALS

A. Utility Company letter of availability for providing electrical service to project.

B. Drawings prepared by Utility Company.

C. Project Record Documents: Record actual locations of equipment and installed service routing.

1.07 QUALITY ASSURANCE

A. Comply with the following:
   1. IEEE C2 (National Electrical Safety Code).
   2. NFPA 70 (National Electrical Code).
   3. The requirements of the Utility Company.
   4. The requirements of the local authorities having jurisdiction.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Utility Company: Duke Energy.

D. Division of Responsibility: As indicated on drawings.

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling.

E. Construct cast-in-place concrete pads for utility equipment in accordance with Utility Company requirements.

F. Provide required protective bollards in accordance with Utility Company requirements.

G. Provide required support and attachment components in accordance with Section 26 05 29.

H. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.

I. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point

dimensions, weight, required clearances, service condition requirements, and installed features.

B. Project Record Documents: Record actual locations of transformers.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F (40 degrees C) maximum.
   2. Less than 10 kVA: 77 degrees F (25 degrees C) maximum.

PART 2 PRODUCTS

2.01 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet (1,000 m).
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).
      b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.02 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.

2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

D. Winding Taps:
1. Less than 3 kVA: None.
2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20.

G. Mounting Provisions:
1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor clean, dry locations: Type 2.
b. Outdoor locations: Type 3R.
2. Construction: Steel.
a. Less than 15 kVA: Totally enclosed, non-ventilated.
b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

I. Accessories:
1. Mounting Brackets: Provide manufacturer's standard brackets.
2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.03 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet (600 mm) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:
   1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.
   2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
   3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.
   4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

K. Identify transformers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

E. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. NEMA PB 1 - Panelboards; 2011.

F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

K. UL 67 - Panelboards; Current Edition, Including All Revisions.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

M. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

B. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

PART 2 PRODUCTS

2.01 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet (2,000 m).
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    a. Indoor Clean, Dry Locations: Type 1.
    b. Outdoor Locations: Type 3R.
2. Boxes: Galvanized steel unless otherwise indicated.
    a. Provide wiring gutters sized to accommodate the conductors to be installed.
    b. Provide painted steel boxes for surface-mounted panelboards, finish to match fronts.
3. Fronts:
    a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
    b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.

K. Load centers are not acceptable.

2.02 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase and Neutral Bus Material: Aluminum or copper.
2. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers:
1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:
1. Provide surface-mounted enclosures.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Aluminum or copper.
3. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers: Thermal magnetic bolt-on or plug-in with retaining clip or locking mechanical restraints type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted enclosures.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
2) 14,000 rms symmetrical amperes at 480 VAC.
b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.
b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
a. Provide the following field-adjustable trip response settings:
1) Long time pickup, adjustable by setting dial.
2) Long time delay.
3) Short time pickup and delay.
4) Instantaneous pickup.
5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
8. Do not use tandem circuit breakers.
9. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.05 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install panelboards plumb.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.

H. Mount floor-mounted power distribution panelboards on properly sized 3 inch (80 mm) high concrete pad.

I. Provide grounding and bonding in accordance with Section 26 05 26.

J. Install all field-installed branch devices, components, and accessories.

K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

M. Provide filler plates to cover unused spaces in panelboards.

N. Identify panelboards in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 50 amperes. Tests listed as optional are not required.

C. Test GFCI circuit breakers to verify proper operation.

D. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

1.02 RELATED REQUIREMENTS

A. Section 26 05 33.16 - Boxes for Electrical Systems.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2017h.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); 2017g.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).

F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

B. Project Record Documents: Record actual installed locations of wiring devices.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices Installed in Unfinished Spaces: White with galvanized steel wall plate.

C. Wiring Devices Installed in Wet or Damp Locations: White with specified weatherproof cover.

2.03 WALL SWITCHES

A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw or double pole single throw as indicated on the drawings.

2.04 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:
   1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

C. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
   2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.05 WALL PLATES

A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard; _____.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

C. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

D. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches (1200 mm) above finished floor.
      b. Receptacles: 18 inches (450 mm) above finished floor or 6 inches (150 mm) above counter.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   4. Locate wall switches on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Identify wiring devices in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Inspect each wiring device for damage and defects.

B. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

C. Test each receptacle to verify operation and proper polarity.

D. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.04 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013 (Corrigendum 2019).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

E. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

F. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2014.

G. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems; 2014.

H. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems; 2015.

I. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.

J. NEMA MG 1 - Motors and Generators; 2017.

K. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

N. UL 508A - Industrial Control Panels; 2013.

O. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.

3. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with dimensions and clearance requirements of actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
6. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
1. Include wiring diagrams showing factory and field connections.

D. Field quality control test reports.

E. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
1. Include contact information for entity providing contract maintenance and trouble call-back service.

F. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

G. Maintenance contracts.

H. Project Record Documents: Record actual installed locations of controllers and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

A. Provide minimum 18-month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Variable-Frequency Motor Controllers - Basis of Design: ABB ACQ580-31 (for low flow pump control) and ACQ580-34 (for duty pump control) Series.

B. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller, non-bypass.
   2. Rectifier/Converter: IGBT-based active front end type.
   3. Control Method: Vector; open-loop, without feedback.

D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

G. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
   6. Input Total Harmonic Distortion: Nominal 3%; Maximum 5%.
      a. Must meet requirements of IEEE 519.

H. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
   1. Rectifier/Converter: IGBT-based active front end type unless otherwise indicated.

I. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
         1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.

2) Vector Control: Provide selectable autotuning function.
b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
c. Selectable braking control; DC injection or flux braking.
d. Adjustable minimum/maximum speed limits.
e. Adjustable pulse width modulation switching carrier frequency.
f. Adjustable motor slip compensation.
g. Selectable auto-restart after noncritical fault; programmable number of time delay between restart attempts.

4. Status Indications:
a. Motor run/stop status.
b. Motor forward/reverse status.
c. Local/remote control status.
d. Output voltage.
e. Output current.
f. Output frequency.
g. DC bus voltage.
h. Motor speed.

5. Protective Functions/Alarm Indications:
a. Overcurrent.
b. Motor overload.
c. Undervoltage.
d. Overvoltage.
e. Controller overtemperature.
f. Input/output phase loss.
g. Output short circuit protection.
h. Output ground fault protection.

6. Inputs:
a. Digital Input(s): Three.
b. Analog Input(s): Two.

7. Outputs:
a. Analog Output(s): One.
b. Relay Output(s): Two.

8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
a. Ethernet Communications: Support for Modbus TCP protocol.
b. Remote Monitoring Capabilities:
1) Motor run/stop status.
2) Fault information.
c. Remote Control Capabilities:
1) Motor run/stop command.
2) Speed adjustment.
3) Fault reset.

9. Features:
a. Password-protected security access.
b. Event log.

J. Power Conditioning/Filtering:
1. Provide LCL filter for controllers with IGBT-based active front end rectifier/converter.

K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.

a. Disconnect Switches: Fusible type or non-fusible type with separate input fuses.
b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

2. Provide door-mounted remote operator interface.
3. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
   b. Packaged Controllers:
      1) Pushbuttons: START/STOP.
      2) Selector Switches: HAND/OFF/AUTO.
      3) Indicating Lights: RUN and FAULT.
      4) Speed Potentiometer, which should only function in HAND mode.

L. Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
   a. Altitude: Less than 3,300 feet (1,000 m).
   b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

M. Short Circuit Current Rating:
1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

N. Conductor Terminations: Suitable for use with conductors to be installed.

O. Enclosures:
1. Comply with NEMA ICS 6.
2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 12.
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

P. Interface with Other Work:
1. Provide products compatible with other systems requiring interface with controllers.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.
      1) Provide thermal magnetic circuit breakers unless otherwise indicated.
      2) Provide electronic trip circuit breakers where indicated.
   b. Interrupting Capacity:

1) Provide circuit breakers with interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.

c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
1) Provide field-adjustable trip response settings:
(a) Long time pickup, adjustable by setting dial.
(b) Long time delay.
(c) Short time pickup and delay.
(d) Instantaneous pickup.

2.04 ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking.

B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
2. Nominal Size: 30 mm.
3. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
4. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
5. Indicating Lights: Push-to-test type unless otherwise indicated.
6. Provide LED lamp source for indicating lights and illuminated devices.

2.05 SOURCE QUALITY CONTROL

A. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. VFD's may be mounted in motor control center or industrial control panel.

C. Install controllers in accordance with NECA 1 (general workmanship).

D. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

E. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

F. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

G. Provide required support and attachment in accordance with Section 26 05 29.

H. Install controllers plumb and level.

I. Mount floor-mounted controllers on properly sized 3 inch (80 mm) high concrete pad.

J. Provide grounding and bonding in accordance with Section 26 05 26.

K. Install field-installed devices, components, and accessories.

L. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

M. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

N. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

O. Identify controllers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 50 amperes. Tests listed as optional are not required.

E. Test for proper interface with other systems.

F. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Location: At project site.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

A. Provide to Owner a proposal as alternate to base bid, a separate maintenance contract for service and maintenance of controllers for two years from date of Substantial Completion; Include complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with detailed schedule.

END OF SECTION

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Generator set enclosure.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 36 00 - Transfer Switches.

1.03 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2017.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.

D. NEMA MG 1 - Motors and Generators; 2017.

E. NFPA 30 - Flammable and Combustible Liquids Code; 2018.

F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2018.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 99 - Health Care Facilities Code; 2017.

I. NFPA 110 - Standard for Emergency and Standby Power Systems; 2016.

J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

L. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
      a. Transfer Switches: See Section 26 36 00.
   2. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition

requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include generator set sound level test data.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

C. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

D. Manufacturer's factory emissions certification.

E. Source quality control test reports.

F. Provide NFPA 110 required documentation from manufacturer where requested by authorities having jurisdiction, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.

G. Manufacturer’s detailed field testing procedures.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

I. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

J. Maintenance contracts.

K. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   3. NFPA 30 (Flammable and Combustible Liquids Code).
   4. All applicable Ohio Codes.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles (320 km) of project site.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with engine generator systems of similar size, type, and complexity; manufacturer's authorized installer.

D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 200 miles (320 km) of project site.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator Set - Basis of Design: Kohler model 600REOZVB with a 5M4030 alternator.

B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
   1. Application: Emergency/standby.
   2. Configuration: Single packaged engine generator set operated independently (not in parallel).

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: 600 kW, standby.
   3. Voltage: 480Y/277 V, 3 phase, 60 Hz.
   4. Main Line Circuit Breaker Number One:
      a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
      b. Trip Rating: 800 amps.
      c. Breaker to be used for standby power to pump station.
   5. Main Line Circuit Breaker Number Two:
      a. Type: Thermal Magnetic.
      b. Trip Rating: 800 amps.
      c. Breaker to be used for load bank connection.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.

4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.
7. Comply with all applicable Ohio codes.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: Size for minimum of 36 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
   c. Features:
      1) Direct reading fuel level gauge.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.
      6) Low fuel level switch.

7) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
a. Battery Type: Lead-acid.
b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
f. Provide alarm output contacts as necessary for alarm indications.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
      e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
      f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
      g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
   3. Generator Set Status Indications:
      a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
      b. Current (Amps): For each phase.
      c. Frequency (Hz).
      d. Real power (W/kW).
      e. Reactive power (VAR/kVAR).
      f. Apparent power (VA/kVA).
      g. Power factor.
      h. Duty Level: Actual load as percentage of rated power.
      i. Engine speed (RPM).
      j. Battery voltage (Volts DC).
      k. Engine oil pressure.
      l. Engine coolant temperature.
      m. Engine run time.
      n. Generator powering load (position signal from transfer switch).
   4. Generator Set Protection and Warning/Shutdown Indications:
      a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:

1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (shutdown).
6) Overspeed (shutdown).
7) Low fuel level (warning).
8) Low coolant level (warning/shutdown).
9) Generator control not in automatic mode (warning).
10) High battery voltage (warning).
11) Low cranking voltage (warning).
12) Low battery voltage (warning).
13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:
1) High AC voltage (shutdown).
2) Low AC voltage (shutdown).
3) High frequency (shutdown).
4) Low frequency (shutdown).
5) Overcurrent (shutdown).
6) Fuel tank leak (warning), where applicable.

c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
a. Event log.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
a. Generator powering load (via position signal from transfer switch).
b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (shutdown).
6) Overspeed (shutdown).
7) Low fuel level (warning).
8) Low coolant level (warning/shutdown).
9) Generator control not in automatic mode (warning).
10) High battery voltage (warning).
11) Low cranking voltage (warning).
12) Low battery voltage (warning).
13) Battery charger failure (warning).

b. Provide audible alarm with silence function.
c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

A. Enclosure Type: Weather protective (non-sound attenuating).

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

A. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

B. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Single step load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.

C. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Identify system wiring and components in accordance with Section 26 05 53.

I. Install remote annunciator and emergency stop pushbutton adjacent to automatic transfer switch.

3.03 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

B. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

E. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.

F. Prepare and start system in accordance with manufacturer's instructions.

G. Perform acceptance test in accordance with NFPA 110.

H. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
   6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).

I. Provide field emissions testing where necessary for certification.

J. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Location: At project site.

C. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE

A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of

Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Non-automatic transfer switches.
   3. Includes service entrance rated transfer switches.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment specified in this section.

E. Section 26 32 13 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.
   2. Includes additional testing requirements.
   3. Includes related demonstration and training requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005, with Errata (2006).

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 110 - Standard for Emergency and Standby Power Systems; 2016.

G. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

H. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
      a. Engine Generators: See Section 26 32 13.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

B. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

C. Source quality control test reports.

D. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

E. Maintenance contracts.

F. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 32 13.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles (320 km) of project site.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
   1. Contract maintenance office located within 200 miles (320 km) of project site.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

B. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:
   1. Basis of Design: Thomson Power Systems TS 870 Series.
   2. Transfer Switch Type: Service entrance rated automatic transfer switch.
   3. Transition Configuration: Open-transition (no neutral position).
   4. Voltage: 277/480V.
   5. Ampere Rating: 800A.
   6. Neutral Configuration: Solid neutral (unswitched), except as indicated.

F. Non-Automatic Transfer Switch:
   1. Basis of Design: Thomson Power Systems TS 870 Series.
   2. Transfer Switch Type: Non-automatic transfer switch.
   3. Transition Configuration: Open-transition (no neutral position).
   4. Voltage: 277/480V.
   5. Ampere Rating: 800A.
   6. Neutral Configuration: Solid neutral (unswitched), except as indicated.

G. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

H. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

I. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

J. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   2. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

K. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

L. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
      b. Outdoor Locations: Type 3R or Type 4.
   2. Provide lockable door(s) for outdoor locations.
   3. Finish: Manufacturer's standard unless otherwise indicated.

M. Short Circuit Current Rating:
   1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

N. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2) Auxiliary contacts; one set(s) for each switch position.
      e. Adjustable Time Delays:
         1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
         2) Transfer to alternate/emergency source time delay.
         3) Retransfer to primary/normal source time delay.
         4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
      f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
      g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
   3. Status Indications:
      a. Connected to alternate/emergency source.
      b. Connected to primary/normal source.
      c. Alternate/emergency source available.
      d. Primary/normal source available.
   4. Automatic Sequence of Operations:
      a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
      b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
      c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
      d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

O. Non-Automatic Transfer Switches:

1. Description: Transfer switches with manually initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:
    a. Manual source selection.
    b. Outputs:
        1) Auxiliary contacts; one set for each switch position.
3. Status Indications:
    a. Connected to alternate/emergency source.
    b. Connected to primary/normal source.
    c. Alternate/emergency source available.
    d. Primary/normal source available.

P. Service Entrance Rated Transfer Switches:
1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source and with ground-fault protection where indicated.
2. Listed and labeled as suitable for use as service equipment according to UL 869A.

Q. Interface with Other Work:
1. Interface with engine generators as specified in Section 26 32 13.

2.03 SOURCE QUALITY CONTROL

A. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install transfer switches plumb and level.

F. Provide grounding and bonding in accordance with Section 26 05 26.

G. Identify transfer switches and associated system wiring in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

A. Prepare and start system in accordance with manufacturer's instructions.

B. Automatic Transfer Switches:
1. Inspect and test in accordance with NETA ATS, except Section 4.
2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.

C. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 32 13.

D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

B. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Location: At project site.

C. Coordinate with related generator demonstration and training as specified in Section 26 32 13.
   1. Transfer switch training time may be coincident with generator training time.

3.06 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.07 MAINTENANCE

A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for distribution locations.

B. Surge protective devices for branch panelboard locations.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.03 ABBREVIATIONS AND ACRONYMS

A. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

A. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

B. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

B. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:
   1. ABB/GE: www.geindustrial.com/#sle.
   2. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com/#sle.
   3. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com/#sle.
   4. Surge Suppression, LLC (SSI): www.surgesuppression.com/#sle.

B. Factory-installed, Internally Mounted Surge Protective Devices:
   1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mounted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:
   1. Wye Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
   1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.
   2. Outdoor locations: Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
   1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.

I. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

2.03 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards.

B. Surge Protective Device:
   1. Protection Circuits: Field-replaceable modular or non-modular.
   2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
   3. Repetitive Surge Current Capacity: Not less than 5000 impulses.

4. UL 1449 Nominal Discharge Current (I-n): 20 kA.
5. UL 1449 Short Circuit Current Rating (SCCR): Not less than the short circuit current rating of the equipment the SPD is connected to, including any series ratings.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

2.04 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
3. Repetitive Surge Current Capacity: Not less than 2,000 impulses.
4. UL 1449 Nominal Discharge Current (I-n): 20 kA.
5. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
7. Provide surge rated integral disconnect switch for SPDs not connected to a dedicated circuit breaker or fused switch or not direct bus connected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.

F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

G. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS Section 7.19.1.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Ballasts and drivers.

D. Lamps.

1.02 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).

C. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.

D. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

H. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

I. UL 1598 - Luminaires; Current Edition, Including All Revisions.

J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

a. Include estimated useful life, calculated based on IES LM-80 test data.

B. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. Provide three year manufacturer warranty for LED luminaires, including drivers.

B. Provide five year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule, legend, or installation notes included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.

H. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps

to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.05 LAMPS

A. Lamps - General Requirements:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Install products in accordance with manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

G. Install accessories furnished with each luminaire.

H. Bond products and metal accessories to branch circuit equipment grounding conductor.

I. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

J. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.

3.06 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

B. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Ballasts.

C. Lamps.

1.02 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

1.03 REFERENCE STANDARDS

A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 1598 - Luminaires; Current Edition, Including All Revisions.

G. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
    a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 WARRANTY

A. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule, legend, or installation notes included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.04 LAMPS

A. Lamps - General Requirements:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires in accordance with NECA/IESNA 501.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

H. Install accessories furnished with each luminaire.

I. Bond products and metal accessories to branch circuit equipment grounding conductor.

J. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

3.06 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

B. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 33 05 00

BURIED PIPING INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes installation, cleaning, and testing of buried piping and covers additional requirements for particular piping systems specified elsewhere in the Project Manual.

B. Furnish all labor, materials, equipment and incidentals required to complete the work.

C. The work includes, but is not limited to, the following:

1. All types of buried piping Work beginning at the outside face of structures or building foundations, unless specifically included under other Sections.

2. Pipe beneath structures.

3. Installation of supports, restraints, and thrust blocks.

4. Work on existing buried pipelines.

5. Installation of all joints, specials, couplings, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, jointing and gasketing materials and all other Work required to complete the piping installation.

6. Valves, gates and specials shown or specified for the piping systems.

7. Testing of pressures per CMS Item 638 as applicable.

8. Cleaning and disinfecting.

9. Piping specifically included with equipment.

D. Related Sections:

1. Section 09 91 10, Painting

2. Section 33 41 20, Ductile Iron Pipe

1.02 REFERENCES

A. Reference Standards:

1. AASHTO M43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction

2. ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

3. ANSI/AWWA C603, Installation of Asbestos-Cement Pressure Pipe

4. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

5. ASTM C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings

6. ASTM C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

7. ASTM C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

8. ASTM C828, Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines

9. ASTM C924, Standard Specification for Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

10. ASTM D1869, Standard Specification for Rubber Rings for Asbestos-Cement Pipe

11. ASTM F1417, Standard Specification for Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

12. AWWA C105, Polyethylene Encasement of Ductile-Iron Pipe Systems

13. AWWA C206, Field Welding of Steel Water Pipe

14. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances

15. AWWA C651, Disinfecting Water Mains

16. AWWA M41, Ductile-Iron Pipe and Fittings

17. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

18. NFPA No. 24, Private Fire Service Mains and their Appurtenances

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Buried Piping Schedule: Comply with the pipe schedule as shown on the Drawings.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit detailed plan and profile drawings for storm and sanitary sewers and drains, regardless of size; and pressure piping over 3 inches in diameter.

2. Submit laying schedules for piping with joints that prohibit field adjustment of pipe lengths.

3. Piping drawings shall include full details of piping, specials, and connections to existing pipes and structures.

4. Submit thrust restraint design evaluations.

B. Product Data: Submit manufacturer's data on all new or replacement equipment, parts and piping.

C. Quality Assurance/Control Submittals:

1. Field Installation Report: Submit installation specialist's report in accordance with paragraph 3.10.C.

2. Test Reports:

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit test results for each system.

3. Submit certification of compliance with Reference Standards.

4. Certificates: Submit a certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.

5. Record Documents:

a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for buried piping Work shall show actual location of all piping and appurtenances at same scale as the Contract Drawings.

b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For each horizontal bend, include dimensions to at least 3 permanent structures, when possible. For straight runs of pipe provide offset dimensions as required to document pipe location.

c. Include profile drawings with buried piping record documents when the Contract Documents include pipe profile drawings.

6. Disinfection: Submit description of forms of chlorine, dosages, and proposed methods of application to the Owner's Representative for approval, 7 days prior to disinfection. Submit successful disinfection certificate.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements:

1. NFPA Standard No. 24: Comply with requirements for "Outside Protection" where applicable to fire protection water piping systems.

2. Obtain required permits for Work in roads, rights of way, railroads, and other areas of the Project.

1.07 DELIVERY, STORAGE AND HANDLING

A. Acceptance at Site:

1. Inspect all equipment and materials against reviewed Shop Drawings at time of delivery.

2. Equipment and materials damaged or not meeting the requirements of the reviewed Shop Drawings shall be immediately returned for replacement or repair.

B. Storage and Protection:

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.

2. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

C. Handling:

1. Handle all pipe, fittings, specials and accessories carefully with approved handling devices and according to the manufacturer. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

2. Avoid unnecessary handling of pipe.

3. Keep pipe interiors free from dirt and foreign matter.

4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	SPECIAL WARRANTY	(Not Used)
1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER'S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Detectable Underground Warning Tape:

1. Seton Name Plate Company

2. EMED Company, Inc.

3. Or approved equal

2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. Piping materials: Required pipe materials are listed in the Piping Schedule. Refer to Applicable Sections for Material Specifications.

B. Pipe Bedding:

1. Comply with the Drawings for type and installation of bedding.

2. Type I or Type II Bedding: Use stone or granular material as specified below:

a. For clay pipe 12 inches and larger, thermoplastic pipe 12 inches and larger, steel pipe 6 inches and larger and all concrete pipe and ductile iron pipe, use one of the following bedding materials:

1) Stone: Use No. 57, No. 67 or No. 8 (AASHTO M 43).

2) Compacted Granular Material: Provide material conforming to the requirements of CMS Item 611.

b. For clay pipe less than 12 inches, thermoplastic less than 12 inches, steel less than 6 inches, and all fiberglass pipes and copper pipe, use one of the following bedding materials:

1) Stone: Use No. 8 (AASHTO M 43).

2) Sand: Conform to the requirements of CMS Item 611.

3. Type III Bedding: If allowed by the Owner's Representative, use undisturbed in-situ existing material. See paragraph 3.05 of this Section.

C. Detectable Underground Warning Tape:

1. Type: Polyethylene with detectable metal core.

2. Size: Not less than 2 inches wide or as recommended by manufacturer for specified depth of burial, full length of trench.

3. Lettering: Black, permanently imprinted message repeated continuously over full length of tape.

4. Color of Tape and Message Text:

   a. Yellow: CAUTION - Gas Line Buried Below.

   b. Yellow: CAUTION - Pipeline Buried Below.

   c. Blue: CAUTION - Water Line Buried Below.

   d. Or similar text on appropriately colored tape as accepted by the Owner's Representative.

D. Water: Water for test, flushing, disinfection or other uses in the Work shall be provided at no cost to the OWNER and shall be free of contaminants.

E. Transition Couplings:

1. Where shown on the drawings or otherwise required and approved by the Owner's Representative, provide a flexible coupling to transition between two different types of pipe materials.

2. Type: Coupling shall have a flexible body that fits snugly over each end of pipe. Low-pressure watertight seal shall be attained by use of bands that tighten around coupling and pipe.

   a. For connecting pipes of different materials with significant variation in outside diameter, a bushing may be used around the smaller pipe.

3. Coupling Body Material: Elastomeric PVC formulated for sanitary sewer service and conforming to ASTM C443, C425, C564 and D1869.

4. Tightening Bands:

   a. Number: Provide 2 or 4 tightening bands as recommended by the manufacturer for the service intended

b. Material: Type 316 stainless steel

c. Type: Worm gear

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)

2.11 SOURCE QUALITY CONTROL

A. Clearly mark each pipe length, outlet, and fitting with designation complying with the Shop Drawings.

B. Paint or cast class designation on each pipe length or fitting 4 inches in diameter and larger.

C. Clearly mark material, type and rating on piping less than 4 inches in diameter at the factory.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not used)

3.02 EXAMINATION

A. Notify the Owner’s Representative before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Documents.

B. All trench excavations shall be inspected by Owner’s Representative prior to laying pipe. Notify the Owner’s Representative in advance of excavating, bedding and pipe laying operations.

3.03 PREPARATION (Not Used)
3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. General:

1. Install piping as shown, specified and as recommended by the manufacturer.

2. Minimum piping cover shall be 4 feet unless otherwise shown or reviewed by Owner's Representative.

3. Comply with Section 200 of the CMS.

4. Place detectable underground warning tape directly above all buried pipe, 1 foot below finished grade.

5. Excavation in excess of that required or shown and that is not authorized by CM shall be replaced at CONTRACTOR's expense with drainage fill furnished, placed, and compacted in accordance with Section 200 of the CMS

6. Comply with NFPA 24 for "Outside Protection", where applicable to water pipe systems used for fire protection.

7. Request instruction from the Owner's Representative before proceeding if there is a conflict between the manufacturer's recommendations and the Drawings or Specifications.

B. Separation of Sewers and Potable Water Pipe Lines:

1. Horizontal and Vertical Separation:

a. Wherever possible, existing and proposed potable water mains and service lines, and sanitary and storm sewers (or any other source of contamination to the potable water supply) shall be separated horizontally by a clear distance of not less than 10 feet.

b. If local conditions preclude a clear horizontal separation of not less than 10 feet, the installation will be permitted provided the potable water main is in a separate trench or on an undistributed earth shelf located on one side of the sewer and at an elevation so the bottom of the potable water main is at least 18 inches above the top of the sewer while still maintaining the minimum depth of buried cover.

c. Exception:

1) Where it is not possible to provide the minimum horizontal and vertical separation described above, both the potable water main and sewer must be constructed of cement mortar lined ductile iron slip-on or mechanical joint pipe complying with public water supply design standards of the agency. Both pipes shall be pressure tested in accordance with the requirements of the buried piping schedule, but in no case less than 150 psi, to assure watertightness before backfilling.

2. Crossings:

a. Provide a minimum vertical distance of 18 inches between the outside of the potable water main and the outside of the sewer with preference to the water main located above the sewer.

b. Center one full-length section of potable water main over the sewer so that the sewer joints will be equidistant from the potable water main joints.

c. Provide adequate structural support where a potable water main crosses under a sewer to maintain line and grade.

d. Exceptions:

1) Where it is not possible to provide the minimum horizontal and vertical separation described above, both the potable water main and sewer must be constructed of cement

mortar lined ductile iron pipe. Both pipes shall be pressure tested in accordance with the requirements of the buried piping schedule, but in no case less than 150 psi, to assure watertightness before backfilling.

2) Encase either potable water main or sewer in a watertight carrier pipe, which extends 10 feet on both sides of the crossing, measured perpendicular to the pipe which is not encased. Each section of encased pipe shall be fitted with at least three casing spacers. End seals shall be installed at either end of the casing pipe.

C. Plugs:

1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.

2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.

3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.

4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to Owner's Representative.

D. Bedding Pipe:

1. Bed pipe as shown and specified. If a conflict exists, review with Owner's Representative before proceeding.

a. For Type I or II bedding conditions, bed pipe evenly to the pipe spring line unless otherwise shown on the drawings.

b. Where the existing material is deemed suitable for Type III bedding by the Owner's Representative,

remove only enough earth to leave a uniform support for the entire length of pipe, except for bells and other joints, which a recess shall be excavated to sufficient depth to relieve joints of load and to allow space for making and inspecting joints around entire circumference.

c. Where the existing material is deemed unsuitable for Type III bedding by the Owner's Representative, remove and replace with approved granular materials in accordance with Type I or Type II bedding conditions.

d. Excavation in excess of that required and which is not authorized by the Owner's Representative shall be replaced with granular bedding material furnished and compacted in accordance with the provisions of the Contract Documents at the CONTRACTOR's expense.

e. Provide 3 inches minimum of bedding material under pipes smaller than 4 inches and 6 inches minimum of bedding material under piping 4 inches and larger where pipe is placed in rock excavation.

2. Carefully and thoroughly compact all pipe bedding and backfill to the pipe spring line with hand held pneumatic compactors.

3. Bed and secure each pipe length in its final position prior to bringing the next subsequent pipe into position.

4. Bedding shall be placed uniformly and simultaneously on each side of the pipe.

5. Comply with all recommended bedding practices of the pipe manufacturer.

6. Comply with Flowable Fill (Low Strength Mortar Backfill) requirements as per CMSC Section 613.

E. Laying Pipe:

1. Comply with manufacturer's instructions and with all applicable standards listed in subparagraph 1.02.A.

2. Install all piping true to line and grade shown unless otherwise approved by the Owner’s Representative. Remove and re-lay all pipes incorrectly laid.

3. Slope piping uniformly between elevations when shown.

4. Ensure that the water level in trench is at least 6 inches below bottom of pipe until backfilling is complete.

5. Lay pipe beginning at lowest point and proceed toward the higher elevations. Point spigot ends in the direction of flow.

6. Excavate around joints in bedding and lay pipe so that only the barrel bears directly on the trench bottom or pipe bedding.

7. Joint deflections shall not exceed 75% of manufacturer's recommended maximum joint deflection.

8. Take every precaution to ensure that no foreign material enters the piping prior to and during installation.

9. Carefully examine all pipe and fittings for cracks, damage or other defects while suspended above the trench just before installation. Remove defective materials from site.

10. Remove all dirt, gravel, sand, debris or other foreign material from the pipe interior before the pipe is moved into the trench.

11. Wire brush bell and spigot mating surfaces and wipe clean and dry immediately before pipe is laid.

12. Close the open ends of piping with a watertight plug whenever laying is not in active progress.

13. Field cut pipe, where required, using specially designed machine.

    a. Make cuts carefully to avoid damage to pipe or lining and to leave smooth right-angle end.

b. Taper cut ends and file sharp edges smooth.

c. Flame cutting shall not be used.

14. Blocking under piping shall be permitted only when accepted by the Owner's Representative for special conditions. Comply with the requirements of applicable reference standards where permitted.

15. Touch-up protective coatings satisfactorily prior to backfilling.

16. All piping shall be inspected by the Owner's Representative prior to any backfilling activity. The CONTRACTOR shall notify Owner's Representative in advance of any backfilling operations.

17. The CONTRACTOR shall remove and re-lay all incorrect, non-conforming, damaged, etc. piping at no additional cost to the OWNER.

F. Polyethylene Encasement:

1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.

2. Polyethylene may be supplied in tubes or sheets.

3. Polyethylene encasement materials and installation shall be in accordance with ANSI/AWWA C105.

G. Jointing Pipe:

1. Completely clean all jointing surfaces and adjacent areas just before making joint.

2. Lubricate and adjust gaskets and O-rings as recommended by manufacturer.

3. Check each gasket carefully for proper position around full circumference of the joint after O-rings are compressed and before pipe is brought fully home.

4. Comply with AWWA C111 and all applicable manufacturers' recommendations pertaining to jointing pipe.

5. Mechanical Joints:

   a. Center and push the plain end into the bell.

   b. Firmly press the gasket evenly into the bell.

   c. Slide the gland to the bell for bolting.

   d. Clean and lubricate bolt threads.

   e. Make joint deflection after assembling joint and hand tightening, but prior to fully tightening bolts.

   f. Tighten all bolts alternately 180 degrees opposite to each other to seat the gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1 1/4	120 to 150

   g. Apply heavy bituminous coating to all bolts and nuts.

6. Flanged Joints:

   a. Use hexagon head nuts and bolts. Bolts shall fully project through the end of the nut to 1/4 inch maximum.

   b. Use 1/8-inch thick full-face gaskets.

   c. Comply with manufacturer's rating and instructions for specified service.

   d. Clean and lubricate bolt threads and gasket faces.

H. Restraints, Supports and Thrust Blocks:

1. Install restrained joints as shown, specified, and as recommended by the manufacturer.

2. Provide concrete and metal cradles, collars, and blocks as shown or otherwise reviewed by the Owner's Representative.

3. Thrust restraint may be accomplished by using restrained piping joints or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure as specified in the Buried Piping Schedule.

4. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

5. Restrained Pipe Joints:

    a. Pipe joints shall be restrained by means suitable for the type of pipe being installed.

        1) Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a restrained joint system as specified in Section 33 41 20, Ductile Iron Pipe, lugs and tie rods, or other joint restraint systems approved by DP. Restrained lengths are shown in the Drawings. The Contractor shall submit a laying schedule depicting the restraining system and restrained lengths with supporting calculations as recommended by the manufacturer for review and approval by the DP. Costs associated with adjustments (increases or decreases) in final restrained lengths shall be accommodated at no additional cost to the owner.

        2) Steel Pipe Joints: Provide butt welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at all mechanical couplings.

3) Thermoplastic and HDPE Joints: Where bell and spigot type or other non-restrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to the approval of DP.

4) Prestressed Concrete Cylinder Pipe Joints: Restrain utilizing clamp type restrained joint, snap ring-type restrained joint, or by welding. Concrete pipe requiring restraint shall have sufficient longitudinal steel reinforcement provided to handle the thrust forces at a maximum design stress of 12,500 psi. Thrust forces in the longitudinals must be transmitted directly to the steel joint bands using welded connections sufficient to carry the stresses involved. No allowance for the concrete to handle tensile forces is allowed. Thrust restraint shall be in accordance with ANSI/AWWA Manual M-9.

5) Joints for Concrete Pipe Other than Prestressed Concrete Cylinder Pipe: Restrain joints utilizing clamp type restrained joint or snap ring-type restrained joint.

6. Harnessed lengths of buried pipe shall be as shown on the Drawings.

I. Transitions between Types of Pipe:

1. Provide all necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or connecting pipe furnished by different manufacturers. Use transition couplings specified in paragraph 2.03.

2. Encase all such connecting joints with 6 inches minimum concrete unless otherwise shown, specified, or recommended by the manufacturer.

J. Closures:

1. Provide all closure pieces shown or required to complete the Work.

2. Locate closures in straight runs of pipe.

K. Backfilling:

1. Comply with applicable requirements of Section 638 of the CMS.

2. Backfill by hand and compact by pneumatic tamping until pipe is covered by at least 1 foot of material.

3. Heavy earth moving equipment and other heavy equipment shall not be moved, placed or used over the pipe until the pipe cover exceeds 4 feet.

L. Adjustment: Adjust all parts and components as required.

M. Concrete Pipe, General: Supplementary Requirements:

1. Joints:

a. Make all joints so that alignment and slope are in accordance with the Drawings and free from internal obstructions.

b. Joints shall be inspected by the Owner's Representative before backfilling.

c. Protect all steel material with a double coating of bitumastic material, minimum 16-mil total thickness.

2. Place pipe containing elliptical reinforcement with the minor axis of the reinforcement in vertical position.

3. Thrust Restraints:

a. Tie joints wherever required to provide thrust restraint where specified on the Drawings.

b. Design the joints to transmit pipeline test pressure axial thrust.

N. Work Affecting Existing Piping:

1. Location of Existing Piping:

a. Locations of existing piping shown should be considered approximate.

b. CONTRACTOR is responsible for determining exact location of existing piping to which it must make connections, may disturb during earth moving operations, or may affect in any way by its work.

2. Removing Existing Pipelines from Service:

a. Pipelines shall not be removed from service unless specifically approved by Owner's Representative.

b. Submit cut-in schedule. File and obtain approval of all necessary outage requests.

c. Notify Owner's Representative at least 48 hours prior to removing each pipeline from service.

3. Work on Existing Pipelines:

a. Cut piping as shown or required using machines designed specifically for this work.

b. Install temporary plugs to keep out all mud, dirt, water and debris.

c. Provide all necessary adapters, fittings, pipe and appurtenances.

d. Comply with all applicable specifications contained herein, including connections or modifications and for cleaning, testing, and disinfecting portions of existing piping modified or to which connections are made.

3.06 APPLICATION (Not Used)
3.07 CONSTRUCTION (Not Used)

3.08 REPAIR/RESTORATION (Not Used)
3.09 RE-INSTALLATION (Not Used)

3.10 FIELD QUALITY CONTROL

A. Prior to laying any pipe, notify Owner's Representative of any unsuitable bedding conditions.

B. Site Tests:

1. General:

a. Test all piping as specified below except as otherwise reviewed by Owner's Representative.

b. Notify Owner's Representative at least 72 hours in advance of testing.

c. Provide all testing apparatus, including pumps, hoses, gages, and fittings.

d. Pipelines shall hold the specified test pressure for the designated period.

e. Repair and retest pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate.

f. Test pressures specified apply at the lowest elevation of the pipeline section being tested unless otherwise noted.

g. Conduct all tests in the presence of the Owner's Representative.

h. The CONTRACTOR is responsible for all testing and shall pay all costs incurred during the specified testing including testing medium.

i. Test representative composite section of each type of piping system before proceeding with remaining piping Work.

2. Test Pressure:

    a. Comply with listing in the Pipe Schedule on the Drawings.

    b. If not listed in the Piping Schedule, test at 10 psi greater than its maximum operating pressure.

3. Pressure Test Procedure:

    a. Place and compact backfill to at least the pipe centerline before testing, or to depth required for proper thrust restraint based on restraint system utilized.

    b. Backfill and compact around all blocking before testing and as required to assure restraint by harnessed joints.

    c. Allow concrete for blocking to reach design strength before testing.

    d. Slowly fill section to be tested with water and expel all air. Install corporation cocks as necessary to remove air.

    e. Apply test pressure, disconnect source, and test in accordance with AWWA C600 for one hour and observe gage. Carefully check for leaks while test pressure is being maintained. If test fails, the CONTRACTOR shall repair line and retest at no additional cost to the OWNER.

    f. Supplemental Testing Requirements for Water Lines: AWWA C600.

4. Leakage Testing:

    a. Conduct leakage test only after satisfactory completion of pressure test.

    b. Allow concrete pipe to stand full of water at least 12 hours prior to starting leakage test.

c. Leakage Test Procedure:

1) Examine exposed pipe, joints, fittings and valves. Stop visible leakage or replace the defective pipe, fitting or valve.

2) Refill the line under test to reach the required test pressure.

3) Place the amount of water permitted as leakage in a container attached to the supply side of the test pump. Seal container. Attach no other source of supply to the pump or line under test.

4) Pump water into the line with the test pump to hold the specified test pressure for 2-hour period.

5) Test fails upon exhaustion of supply or inability to maintain the required pressure. Water remaining in the container shall be measured and the amount used during the test shall be recorded on the test report.

6) All repair, replacement, and retesting required because of the failure to meet testing requirements shall be made by the CONTRACTOR at his cost.

d. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to the pipe segment being tested to maintain pressure within 5 psi of the test pressure during the timed test period. Allowable leakage rates for piping are:

1) No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

2) Rates based on formula or table in ANSI/AWWA Manual M41:

a) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:

(1) Bell and spigot and push-on joints

(2) Mechanical joints

(3) Bolted sleeve type couplings

(4) Grooved and shouldered couplings

3) Rates based on make-up allowance in ANSI/AWWA Manual M9:

a) Prestressed concrete cylinder pipe and other types of concrete pipe joined with O-ring rubber gasket sealing members.

4) Rates based on formula or table in ANSI/AWWA C605:

a) Plastic pipe joined with O-ring gasket sealing members.

5) Rates based on formula or table in ANSI/AWWA C603:

a) Asbestos-cement pipe.

5. Infiltration Testing:

a. Sewage and drain piping may be leakage tested by measuring infiltration in lieu of pressure testing where ground water exists at least 2 feet higher than top of pipe.

b. Test Sections shall be limited to 1000 feet maximum.

c. Provide bulkhead at upper end of pipe section.

d. Install a calibrated weir at lower end of section and measure leakage for 4-hour minimum.

e. Leakage shall not exceed 1 gallon per hour per 1,000 feet per inch diameter.

6. Vertical Deflection Test for Plastic Pipe:

a. Manually pull a pin-type vertical gauge mounted on a sled through each section of pipe after completion of backfill at a time acceptable to the Owner's Representative.

1) Set the gauge to stop where vertical deflection of pipe exceeds 5%.

2) Excavate and relay all piping failing test.

7. Exfiltration Testing:

a. Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.

b. Before measuring leakage, allow fluid to wet pipe interior for the following period:

1) Concrete Pipe: 48 hours

2) Cement mortar-lined Pipe: 24 hours

3) Asbestos-cement Pipe: 24 hours

4) Other Pipe: Wetting period not required

c. Maintain hydrostatic head during the test to equal an elevation 2 feet above the present and future maximum groundwater elevation at the pipe segment tested. Owner's Representative will determine the test water surface elevation for each pipe segment.

d. Provide a minimum hydrostatic head during the test of 2 feet above the crown of the upstream end of the pipe segment tested.

e. Add fluid from a test container or from a metered supply as required to maintain the test water level within 3 inches of the test head throughout the test.

f. Test duration shall be at least 2 hours.

g. Allowable Leakage Rates:

1) Leakage is defined as the quantity of fluid that must be supplied to the pipe segment tested to maintain the hydrostatic head within 3 inches of the test head during the test after the pipe has been filled and exposed to the required wetting period, plus the quantity required to refill to the original head at end of test.

2) Leakage shall not exceed that allowed by the regulatory authority having jurisdiction.

8. Sewer Testing with Low Pressure Air:

a. Plug and bulkhead ends and lateral connections of pipe segment to be tested.

b. Required test pressure shall be increased by an amount equal to the elevation of groundwater above the invert of the lowest point of the pipe segment being tested.

c. Test in accordance with requirements of regulatory authority having jurisdiction.

d. If there are no regulatory requirements, use test procedures described in the following standards:

1) Thermoplastic and HDPE Pipe: ASTM F1417

2) Concrete Pipe: ASTM C924

3) Clay Pipe: ASTM C828

9. Vacuum Testing:

    a. Plug and bulkhead ends and lateral connections of pipe segment or manhole to be tested.

    b. Following set-up of test apparatus, draw vacuum of ten inches of mercury on the pipe segment or manhole being tested.

    c. Start test upon reaching the specified test vacuum. Test duration shall be 15 minutes.

    d. Record vacuum drop at end of test. If vacuum drop is greater that one inch of mercury, pipe segment or manhole fails the test and shall be repaired and retested. If vacuum drop is less than one inch of mercury, pipe segment or manhole passes the test.

10. Process Air Pipe Testing:

    a. General:

        1) Test pipe before backfilling the pipe trench.

        2) Maintain groundwater level below bottom of trench until test is successfully completed.

        3) Required test pressure is listed in Buried Piping Schedule.

    b. Preparation for Testing:

        1) Provide temporary tie rods at expansion joints as required.

        2) Verify that pipe supports, where present, are secure.

        3) Test one pipe segment at a time. Use temporary blind flanges and isolators as required.

4) Install corporation cocks for filling and relieving air. Provide temporary automatic pressure relief valve and pressure gauge with range suitable for test pressure.

c. Test Procedure:

1) Pressurize pipe segment being tested with air to the required test pressure. Maintain pressure for at least two hours.

2) Apply a soapy water solution to all joints to check for leakage, indicated by presence of bubbles, while test pressure is maintained.

3) Allowable Leakage: Zero (0).

d. Repair and retest pipelines that fail the test.

e. After the testing is complete, remove temporary measures provided for testing and provide Type 304 stainless steel threaded plugs at taps used for test.

C. Manufacturer's Installation Specialist:

1. Provide competent manufacturer's installation specialist services for initial laying of the following piping types:

a. UHMWHD Polyethylene, specified in Section 15065, Thermoplastic Pipe

2. Retain specialist on the job until pipe laying crew competency has been satisfactorily demonstrated, but not less than 2 days.

3. Submit manufacturer's installation inspection report addressing the following:

a. Deficiencies found.

b. Recommended corrective action for deficiencies.

c. Certification that all items are properly installed.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Thoroughly clean and flush all piping prior to placing in service in a manner acceptable by the Owner's Representative. Inspect inside of piping 24 inches diameter and larger and remove all debris, dirt and foreign matter.

B. Potable Water Disinfection:

1. Standard: AWWA C651 unless otherwise approved by the Owner's Representative

2. Disinfect and test for disinfection all potable water piping.

3. Flush piping with water at 2 1/2 fps minimum velocity prior to disinfection.

4. Water for flushing, testing and chlorination will be at no cost to OWNER.

5. Chlorine shall be supplied by CONTRACTOR.

6. All labor, material and equipment including chlorination taps and blow-off taps shall be furnished and paid for by the CONTRACTOR.

7. Bacteriological tests will be performed by the Owner's Representative. Certified laboratory test reports shall be available to the CONTRACTOR if requested.

8. Chlorine Concentration:

a. Maintain chlorine concentration between 50 and 100 ppm for water entering the pipe.

b. 25 ppm minimum residual concentration shall remain after 24-hour retention period.

c. Repeat the operation as necessary to provide complete disinfection.

3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 33 10 00

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall install conduit systems via horizontal directional drilling (HDD) operations to avoid roadway impacts and as described herein.

B. Related Sections:

1. Division 26, Electrical

1.02 REFERENCES

A. Reference Standards:

1. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

B. Each Section of the Specifications is not necessarily complete in itself and all Sections of the Specifications are related. Contractor shall read each Section in conjunction with all the other Contract Documents. Contractor shall also ensure that all Subcontractors read the relevant documents and comply with the requirements.

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back the conduit, a drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system or walk over system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid

volume, and trained, competent personnel to operate the system. All equipment shall be in good, safe condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

B. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations. There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.

C. Drill Head: The drill head shall be steerable by changing its rotation and shall provide necessary cutting surfaces and drilling fluid jets.

D. Mud Motors (IF REQUIRED): Mud motors shall be of adequate power to turn the required drilling tools.

E. Drill Pipe: The Contractor is solely responsible to ensure the drill pipe is adequate to withstand the torque and longitudinal forces associated with the drilling operation.

F. Pipe Rollers: Pipe rollers shall be used for pipe assembly during final product pull back.

G. Guidance System: An electronic walkover tracking system or a Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to twenty feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate and calibrated to manufacturer’s specifications of the vertical depth of the borehole at sensing position at depths up to twenty feet and accurate to one foot horizontally on either side of

the borehole. The Contractor shall supply all components and materials to install, operate, and maintain the guidance system. The Guidance System shall be of a proven type, and shall be set up and operated by personnel trained and experienced with the system. The operator shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

H. Drilling Fluid (Mud) System: A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder and to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be minimum of 1,000 gallons. Mixing system shall continually agitate the drilling fluid during drilling operations.

I. Drilling Fluids: Drilling fluid shall be composed of clean water and bentonite clay. Water shall be from an authorized source with a pH of 8.5 - 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. No additional material may be used in drilling fluid without prior approval from the Owner. The bentonite mixture used shall· have the minimum viscosities as measured by a March funnel:

Rocky Clay - 60 seconds
Hard Clay - 40 seconds
Soft Clay - 45 seconds
Sandy Clay - 90 seconds
Stable Sand - 80 seconds
Loose Sand - 110 seconds

These viscosities may be varied to best fit the soil conditions encountered, or as determined by the operator.

J. Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Owner prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated without undo stoppage and maintain line and grade within the tolerances prescribed by the particular conditions of the project.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project. Equipment shall include but not be limited to: drilling rig, mud system, mud motors (if applicable), downhole tools, guidance system, and rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that Contractor intends to use, or might use, shall be submitted.

2. Prior to mobilizing to the site, the Contractor shall submit a drilling plan to the Owner for approval. The plan shall depict the sequence of drilling operations and have clearly identified the entry and exits points along with necessary layout areas. In addition, the plan shall identify the pilot hole drilling procedure, reaming procedure, pullback procedure, ballasting, use of rollers, side booms and side rollers. Provisions for ensuring integrity of the polyethylene encasement during pull back shall also be identified. The plan shall identify the types of drilling fluids to be used, cleaning and recycling procedures, estimated flow rates and provisions to minimize fluid escape. The drilling plan shall be submitted for review and approval by the Owner.

3. Upon completion of the pilot hole phase of the operation, a complete set of "as-built" records shall be submitted in duplicate to the Owner. These records shall include copies of the plan and profile drawing, as well as directional survey reports as recorded during the drilling operation. Actual coordinates relative to horizontal and vertical position of the bore hole shall be identified on the plan at intervals not exceeding 25 feet. Upon completion and approval of the pilot hole location the reaming directional drilling phase shall begin.

1.06 QUALITY ASSURANCE

A. All directional drilling operations shall be performed by a qualified directional drilling Contractor with at least (3) years' experience involving work of a similar nature to the work required with this project.

B. All personnel shall be fully trained in their respective duties as part of the directional drilling crew, and in safety. Each person must have at least two years directional drilling experience. A competent and experienced supervisor representing the Contractor shall be present at all times during the actual drilling operations. A responsible representative who is thoroughly familiar with the equipment and type of work to be performed must be in direct charge and control of the operation at all times. In all cases, the supervisor must be continually present at the job site during the actual Directional Bore operation. The Contractor shall have a sufficient number of competent workers on the job at all times to insure the Directional Bore is made in a timely and satisfactory manner. Personnel who are unqualified, incompetent or otherwise not suitable for the performance of this project shall be removed from the job site and replaced with a suitable person.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

B. Acceptance at Site:

1. All materials shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify Owner’s Representative, in writing, if any loss or damage exists to equipment or components or if there is a deviation from the approved Shop Drawings. Replace loss or deviations and repair damage to new condition in accordance with manufacturer's instructions.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)

1.11 WARRANTY

A. Provide documentation that the manufacturer shall guarantee against defects in material or workmanship for a period of 10 years.

1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER'S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01	MANUFACTURERS	(Not Used)
2.02	DESIGN CRITERIA	

A. The mud pumping system shall have a minimum capacity of 35-500 GPM and the capability of delivering the drilling fluid at a constant minimum pressure of 1200 psi. The delivery system shall have filters in-line to prevent solids from being pumped into drill pipe. Used drilling fluid and drilling fluid spilled during operations shall be contained and conveyed to the drilling fluid recycling system or shall be removed by vacuum trucks or other methods acceptable to the Owner. A berm, minimum of 12-inches high, shall be maintained around drill rigs drilling fluid mixing system, entry and exit pits, and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey drilling fluid containment areas to storage and recycling facilities for disposal.

2.03	MATERIALS	(Not Used)
2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)
2.11	SOURCE QUALITY CONTROL	(Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions:

1. Inspect all items immediately upon delivery to site for damage.

2. The Contractor shall be responsible for having determined to his satisfaction, prior to the submission of his bid, the nature and location of the work, the ground conformation, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions and all other matters which can, in any way affect the work under this Contract. The prices established for the work to be done will reflect all costs pertaining to the work described in these specifications.

3.03 PREPARATION (Not Used)
3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. HDD operations shall consist of the drilling of a small diameter pilot hole from one end of the alignment to the other, followed by enlarging the hole diameter for the conduit insertion. The exact method and techniques for completing the directionally drilled installation will be determined by the Contractor, subject to the requirements of this Section. The required piping shall be assembled in a manner that does not obstruct adjacent roadways or public activities. The Contractor may be required to erect temporary fencing around the entry and exit conduit staging areas.

B. The Contractor shall provide all material, equipment and facilities for directional drilling. Proper alignment and elevation of the bore hole shall be consistently maintained throughout the directional drilling operation. The method used to complete the directional drill shall conform to the requirements of all applicable permits. Piping shall be installed in close conformance with the conduit profile

identified on the plan. At no time shall the conduit be installed at a depth less than that identified on the profile. If the Contractor requests a change to the conduit alignment (vertical or horizontal), such requests must be submitted in writing, including a detail depicting the requested change to the Owner. Approval, if granted will only be provided in writing. Bore profiles demonstrating compliance with the design profile must be submitted for piping work claimed on each request for payment. The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.

C. Contractor shall place a silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection necessary by documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures.

D. The pilot hole shall be drilled on the bore path with no deviations greater than inches of depth. In the event that pilot does deviate from the bore path more than the defined allowance, Contractor will notify the Owner and the Owner may require Contractor to pull-back and re-drill from the location along bore path before the deviation.

E. In the event that a drilling fluid fracture, inadvertently returns or a returns loss occurs during pilot hole drilling operations, Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and wait another 30 minutes. If mud fracture or returns loss continues, Contractor will discuss additional options with the Owner and work will then proceed accordingly.

F. The final hole enlargement shall not exceed by 1.5 times the outer diameter of the conduit. The Contractor is required to grout any voids (including annular space) as directed by the Owner.

G. The open bore hole may be stabilized by means of bentonite drilling slurry pumped through the inside diameter of the drill rod and through openings in the reamer. The drilling slurry must be in a homogenous/flowable state serving as an agent to carry the loose

cuttings to the surface through the annulus of the borehole. The bentonite slurry is to be contained at the exit or entry side of the directional bore in pits or holding tanks. The slurry may be recycled at this time for re use in the hole opening operation, or shall be hauled by the Contractor to an approved dumpsite for authorized disposal.

H. Following completion of the bore hole the product conduit shall be pulled through the hole by means of a pulling eye attached to the lead joint of the conduit. A swivel shall be used to connect the conduit to the drill pipe to prevent torsional stresses from occurring in the conduit.

3.06 APPLICATION (Not Used)
3.07 CONSTRUCTION (Not Used)
3.08 REPAIR/RESTORATION

A. Following horizontal directional drilling operations, Contractor will de-mobilize equipment and restore the work site to the original condition or better. All excavations will be backfilled and compacted according to the CMS or as directed by the Owner.

3.09 RE-INSTALLATION (Not Used)
3.10 FIELD QUALITY CONTROL (Not Used)
3.11 ADJUSTING (Not Used)
3.12 CLEANING (Not Used)
3.13 DEMONSTRATION (Not Used)
3.14 PROTECTION (Not Used)
3.15 SCHEDULES (Not Used)

+ + END OF SECTION + +

SECTION 33 41 20

DUCTILE-IRON PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for ductile-iron pipe systems and ductile iron or cast iron fittings, abrasion resistant pipe systems and specials.

B. Furnish all labor, materials, equipment and incidentals required to complete the work.

C. The extent of ductile iron piping is shown on the Drawings.

D. Related Sections:

1. Section 09 91 10, Painting

2. Section 33 05 00, Buried Piping Installation

3. Section 40 05 05, Exposed Piping Installation

4. Section 40 05 06, Piping Accessories

1.02 REFERENCES

A. Reference Standards:

1. ANSI B18.2.1, Square and Hex Bolts and Screws (Inch Series)

2. ANSI B18.2.2, Square and Hex Nuts (Inch Series)

3. ASTM A194, Standard Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

4. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

5. ASTM C283, Standard Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid

6. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

7. ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

8. AWWA C104/ANSI A21.4, Cement-Motor Lining for Ductile-Iron Pipe and Fittings for Water

9. AWWA C105/ANSI A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems

10. AWWA C110/ANSI A21.10, Ductile-Iron and Gray-Iron Fittings for Water

11. AWWA C111/ANSI A21.11, Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

12. AWWA C115/ANSI A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

13. AWWA C151/ANSI A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

14. AWWA C606, Grooved and Shouldered Joints

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Service Conditions: Convey liquids or gases as required in the Specifications and as shown on the Drawings.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit detailed drawings and data on pipe, fittings, gaskets and appurtenances in conjunction with Shop Drawings required under Sections 30 05 00, Buried Pipe Installation, and 40 05 05, Exposed Piping Installation.

2. Surface Preparation and Application Reports:

a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the Shop Drawing.

b. Test procedures and test results for linings and coatings in pipe and fittings.

c. Sample of pipe and fitting with each type of lining, for use at the Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.

d. Lining and coating test coupons.

3. Certificates:

a. Submit a certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.

B. Product Data: Submit manufacturer's data on all new or replacement equipment, parts, and piping.

C. Quality Assurance/Control Submittals: Comply with 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation, and the following:

1. Submit certificates of compliance with reference standards.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Product Delivery, Storage and Protection: Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)
1.11 WARRANTY (Not Used)
1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)
1.15 MAINTENANCE (Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS (Not Used)
2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. Ductile-Iron Pipe and Fittings:

1. Pipe:

a. Flanged:

1) Standard: AWWA C115 (ANSI A21.15).

2) Thickness: Comply with Pipe Schedule on Drawings. If not shown, use Class 53, as a minimum.

b. Non-Flanged:

1) Standard: AWWA C151 (ANSI A21.51).

2) Thickness: Comply with Pipe Schedule on Drawings. If not shown, use Class 53, as a minimum.

2. Joints: As shown on the Drawings. If not designated, use radius cut grooved joints for exposed piping and push-on or mechanical joints for buried piping.

a. Flanged:

1) Standard: AWWA C110 (ANSI A21.10).

2) Gaskets: 1/8-inch thick red rubber, full face.

a) Air Main Service: 250°F high temperature type.

3) Bolts and Nuts:

a) Standard: ANSI B18.2.1 and ANSI B18.2.2, respectively.

b) Material, Exposed: ASTM A307, Grade B.

c) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.

b. Mechanical Joint:

1) Standard: AWWA C111 (ANSI A21.11).

2) Gaskets:

a) General: Plain rubber.

b) Air Main Service: 250°F high temperature type.

3) Bolts and Nuts: High strength low alloy steel.

c. Grooved and Shoulder:

1) General: Install piping system using grooved pipe with square cut ends and mechanical pipe couplings with a central cavity design pressure-responsive gasket. Comply with AWWA C606.

2) Pipe Preparation: Comply with applicable requirements of ANSI/AWWA C606 regarding pipe material, wall thickness, size, type of coupling, etc. and the coupling manufacturer's recommendations and requirements.

3) Couplings:

a) Material and product as specified in Section 40 05 06, Piping Accessories.

b) Type and Location: Rigid or flexible to be as recommended by coupling manufacturer as required in Section 40 05 05, Exposed Piping Installation.

4) At valves, pumps and equipment not available with grooved or shouldered pipe end joint construction, provide joints that allow for quick joint disassembly for simple removal of item from piping system.

5) Gaskets: Comply with Section 40 05 06, Piping Accessories.

6) Pipe Ends and Fittings:

a) 36-inch diameter or less: Grooved End.

b) Greater than 24-inch diameter: Shouldered (or collared) end.

d. Push-On: Comply with AWWA C111 (ANSI A21.11).

e. Restrained: Use one of the following systems:

1) Flex-Ring by American Cast Iron Pipe Company

2) Super Lock by Clow Corporation

3) TR-Flex by U.S. Pipe

4) Or approved equal

f. Mechanical Joint Restraint: Use one of the following systems:

1) MEGALUG®

2) Or approved equal

3. Fittings:

a. Standard: ANSI A21.10

b. Pressure Rating: Class 250, unless otherwise specified.

c. Material: Ductile-iron or cast-iron.

d. Gaskets: Comply with specifications for joints.

e. Bolts and Nuts: Comply with specifications for joints.

f. Restrained Joint Systems: Use fittings with restrained joint system specified above.

B. Specials:

1. Transition Pieces:

a. Furnish suitable transition pieces for connections to existing piping.

b. Expose existing piping to determine material, dimensions and other data required for transition pieces and to confirm details shown on Drawings.

2. Taps:

a. Provide taps where shown or required for small pipe connections and other purposes.

b. Where pipe or fitting wall thickness is inadequate to provide required minimum number of threads, provide a boss or pipe saddle. Provide boss or pipe saddle for all taps over 2 inches in size.

3. Pipe Adapters: Provide necessary adapters to join pipe of different types. Comply with specifications for respective joints.

4. Unit Flanges:

a. Manufacturers:

1) E-Z Flange by EBAA Iron Sales, Inc.

2) Uni-Flange by The Ford Meter Box Company, Inc.

3) Or approved equal

b. Materials:

1) Flange: Ductile-iron Grade 65-45-12

2) Set Screws: AISI 4140 Steel

3) Gasket:

a) Rubber

b) Air Main Service: 250°F high temperature type.

c. Thrust Restraint: Equal to standard thread on flange.

5. Couplings:

a. Refer to Section 40 05 06, Piping Accessories.

6. Concrete Thrust Blocks:

a. Shall be per CMS Item 638.

C. Polyethylene Encasement:

1. Provide polyethylene encasement on buried ductile-iron pipe, fittings, and accessories as noted on Drawings.

2. Provide in accordance with AWWA C105 (ANSI A21.5).

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)

2.09 FABRICATION

A. All pipe fabrications for this work shall be based upon approved shop drawings. Shop drawings shall be based upon accurate field verification, by the CONTRACTOR, of all dimensions, elevations, alignments, obstacles, equipment locations, connections and terminations and all other field data critical to the installation of the piping systems.

B. Grooved End Pipe Fabrication:

1. All pipe, couplings, flanges and fittings shall be provided by the grooved end pipe-coupling manufacturer and, insofar as possible, shall be the products of the grooved coupling manufacturer.

2. All pipe ends and fittings shall be cut and grooved in the manufacturer's facility.

a. Pipes shall be accurately cut to the lengths indicated on the approved shop drawings and shall be tagged or stenciled with identifications.

b. All cutting and grooving shall be in strict accordance with the manufacturer's specifications.

c. Field cutting, grooving or modifications to pipe lengths by the CONTRACTOR shall not be permitted, unless the CONTRACTOR has received prior training, has the correct equipment and tools, and is certified by the grooved end pipe coupling manufacturer to make such modifications.

1) Comply with submittal requirements stated in Section 40 05 05, Exposed Pipe Installation.

2) Comply with requirements of Section 40 05 05, Exposed Pipe Installation, regarding field cutting and grooving of pipe.

2.10 FINISHES

A. Coatings and Linings:

1. Inside Wall of Pipe and Fittings:

a. Cement Lining:

1) Standard: ANSI A21.4

2) Thickness: Standard

3) Seal Coat: Asphaltic

4) Use: All ductile and cast iron pipe and fittings (except air lines) unless specifically noted otherwise.

b. Unlined: All ductile and cast iron pipe and fittings used for air lines shall be unlined (bare metal).

c. Polyethylene Lining:

1) Material Standard: ASTM D1248

2) Thickness: Nominal 40 mils

3) Application: Heat bonded

4) Use: Only where specifically scheduled or noted on Drawings.

5) Manufacturer:

a) "Polybond" by American Cast-Iron Pipe Company

b) "Polylined" by U.S. Pipe

c) "Polyethylene Lined" by Clow Corporation

d) Or approved equal

d. Glass Lining

1) Glass lining shall have a hardness of 5-6 on the MOHS scale, and a density of 2.5-3.0 grams per cubic centimeter as measured by ASTM D792. The glass lining shall be capable of withstanding an instantaneous thermal shock of 350°F differential without crazing, blistering, or spalling. Glass lining shall be resistant to corrosion of between a pH of 3 and 10 at 125°F. There shall be no visible loss of surface gloss to the lining after immersing a product sample in an 8% sulfuric acid solution at 148°F for a period of 10 minutes. When tested according to ASTM C283, it shall show a weight loss of not more than 3 milligrams psi.

2) All sludge piping shall be glass lined, unless shown or specified otherwise.

3) No field tapping of glass lined piping shall be permitted unless otherwise approved by Owner's Representative.

2. Outside Wall of Pipe and Fittings:

a. Buried:

1) Coating: Asphaltic paint as specified under the applicable ANSI or AWWA specification.

b. Exposed: Comply with Section 09 91 10, Painting, for Ferrous Metals.

2.11 SOURCE QUALITY CONTROL

A. Obtain pipe and each type of fitting from only one manufacturer.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.03 PREPARATION

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.06 APPLICATION

A. Grooved and Shoulder pipe shall not be used for process piping and is limited in use to potable water systems.

3.07 CONSTRUCTION (Not Used)
3.08 REPAIR/RESTORATION (Not Used)
3.09 RE-INSTALLATION (Not Used)

3.10 FIELD QUALITY CONTROL

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.13 DEMONSTRATION (Not Used)
3.14 PROTECTION (Not Used)
3.15 SCHEDULES (Not Used)

+ + END OF SECTION + +

SECTION 33 50 00

TUNNEL – JACKED LINER

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing a tunnel liner of sufficient diameter to permit the installation of the force main therein and encasing the force main in the liner. This work includes all excavation, shoring and bracing, jacking pit and appurtenances (except for separate contract pay item), backstops, jacks, jacking shields, hoods, breasting attachments, grout holes and plugs, grout and other incidentals as needed for the installation. The Contractor may install the liner by jacking and hand mining, by spoil removal with a boring auger, or by tunnel boring machine.

B. Related Sections:

1. Section 33 05 00, Buried Pipe Installation

2. Section 33 41 20, Ductile Iron Pipe

1.02 REFERENCES

A. Reference Standards:

1. C-76, Reinforce Concrete Culvert, Storm Drain, and Sewer Pipe

2. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

B. Each Section of the Specifications is not necessarily complete in itself and all Sections of the Specifications are related. Contractor shall read each Section in conjunction with all the other Contract Documents. Contractor shall also ensure that all Subcontractors read the relevant documents and comply with the requirements.

1.03 DEFINITIONS

A. Boring: This method consists of pushing (jacking) the pipe into the earth with a boring auger rotating within the pipe to remove the spoil.

B. Jacking. This method consists of pushing sections (strings) of pipe into position with a tunnel boring machine, or with jacks placed against a backstop and excavation performed by hand within the jacking shield or liner at the head of the pipe. Jack in one direction only.

1.04 SYSTEM DESCRIPTION

A. Jacking Shield for Reinforced Concrete Pipe. Provide a separate jacking shield, a tunnel boring machine or a shield fabricated as a special section of reinforced concrete pipe with steel cutting edge, hood, breasting attachments, and other necessary appurtenances cast into the pipe if required by the Engineer. Design the wall thickness and reinforcing for the jacking stresses. Do not plan for the fabricated shield to remain as a part of the tunnel liner, unless specifically designed for that purpose and the design is approved by the Engineer.

B. Jacking Shield for Smooth Steel Pipe Liner. Provide a separate shield, or the leading section of conduit equipped with a securely anchored jacking head to prevent wobble and variation in alignment if required by the Engineer. The Contractor may use a modified section of standard pipe with the necessary breasting attachments and capability to completely bulkhead the face if approved by Engineer.

C. Boring Head and Auger Assembly. Submit details showing the equipment and the methods of operation the Contractor plans to use. The Engineer may require devices to prevent the cutting head from leading the pipe. Use a cutting head designed to obstruct the flow of soft or poor soil through the face. Use a cutter head and auger assembly designed to allow the entire removal of the boring equipment from inside the liner. Limit the over cut to the minimum amount required for the installation and conduct operations to prevent unsupported excavation ahead of the liner pipe.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit complete Shop Drawings including dimensions, materials and parts lists.

2. Submit to the Engineer design calculations prepared and stamped by a Professional Engineer registered in the State of Ohio demonstrating the capability of the materials proposed.

3. Casing pipe thickness calculations.

4. Boring head and auger assembly equipment submittal with methods of operation.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

B. Storage and Protection:

1. Store materials in a secure location to permit easy access for inspection and identification. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:

1. All materials shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify Owner's Representative, in writing, if any loss or damage exists to equipment or components or if there is a deviation from the approved Shop Drawings. Replace loss or deviations and repair damage to new condition in accordance with manufacturer's instructions.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)

1.10 SCHEDULING (Not Used)

1.11 WARRANTY

A. Provide documentation that the manufacturer shall guarantee against defects in material or workmanship for a period of 10 years.

1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)
1.15 MAINTENANCE (Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS (Not Used)

2.02 DESIGN CRITERIA

A. Tunnel lining with strength commensurate with the tunnel diameter, depth of cover, and jacking thrust and with adequate buckling resistance, all in accordance with the design requirements of the authorizing entity.

2.03 MATERIALS

A. Reinforced Concrete Pipe Liner. Provide reinforced concrete pipe liner with tongue and groove joints conforming to ASTM C-76, Class V Wall C. Provide a pipe design for approval by the Engineer.

B. Smooth Steel Pipe. Provide smooth steel pipe having a minimum yield strength of 35,000 psi with a diameter as specified in the following table.

Nominal Diameter (Inches)	Nominal Thickness (Inches)
16	0.281
54	0.781

The Engineer will consider wall thicknesses for other conditions of loading if justified by the submitted engineering calculations. Fully weld joints

between sections of steel pipe around the circumference. Provide any stress transfer across the joint necessary to ensure capability to resist the jacking forces involved.

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)
2.11	SOURCE QUALITY CONTROL	(Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions:

1. Inspect all items immediately upon delivery to site for damage.

3.03	PREPARATION	(Not Used)
3.04	ERECTION	(Not Used)

3.05 INSTALLATION

A. Installation shall be in strict accordance with the Contract Documents and the requirements outlined in the manufacturer's written instructions and shop drawings. It is the Contractor's responsibility to verify the accuracy of all necessary dimensions in the field to ensure compatibility with the specifications and equipment.

B. Excavate all material of whatever nature encountered, including rock, necessary for the construction of the work. The Owner

considers all excavated material as unclassified material. Do not excavate beyond the edge of the hood, shield or liner, except in rock.

C. Perform all dewatering as specified in the Drawings.

D. The Contractor may place grout by grout pipes from the ground surface where conditions permit. On main highway installations, place the grout from within the jacked liner, or other approved method. For reinforced concrete pipe, provide grout holes cast into the liner at manufacture. Space the holes 4 feet longitudinally and approximately 3 feet circumferentially. For other installations, the Engineer will approve the grouting arrangement. Use grout with a 1:3 (cement:sand) cement grout mixture. Start the grouting immediately after completing the jacking/boring operation. Provide a grouting machine, gauge, pressures, and cold weather instructions.

E. After installation of the force main in the tunnel lining, completely fill the space between the tunnel liner and the force main with 1:5 (cement:sand) Portland Cement grout or CMS Item 613, Low Strength Mortar Backfill.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)
3.10	FIELD QUALITY CONTROL	(Not Used)
3.11	ADJUSTING	(Not Used)
3.12	CLEANING	(Not Used)
3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes installation, cleaning, and testing of exposed piping and covers additional requirements for particular piping systems specified elsewhere in the Project Manual.

B. Furnish all labor, materials, equipment and incidentals required to complete the work.

C. The work includes, but is not limited to, the following:

1. All types of exposed piping unless specifically included under other Sections.

2. Piping embedded in concrete within a structure or foundation.

3. Restraints, thrust blocks and kickers.

4. Work on existing exposed pipelines.

5. Installation of all joints, specials, couplings, sleeve couplings, mechanical couplings, harnessed and flanged adapters, expansion couplings, sleeves, tie rods, jointing and gasketing materials and all other work required to complete the piping installation.

6. Valves, gates and specials shown or specified for the piping systems.

7. Testing of pressures as shown in the Pipe Schedules on the Drawings.

8. Cleaning and disinfecting.

9. Installation of magnetic flow tubes, insert flow tubes, mechanical meters, and venturi meters for the piping systems.

10. Piping specifically included with equipment.

D. Related Sections:

1. Section 09 91 10, Painting

2. Section 40 05 06, Piping Accessories

3. Section 40 05 07, Supports and Anchors

4. Section 40 05 09, Wall Pipes, Floor Pipes, and Pipe Sleeves

1.02 REFERENCES

A. Reference Standards:

1. ASME B31.3, Code for Process Piping

2. ASME BPVC-CC-BPV, Boilers and Pressure Vessels

3. AWS D1.1, Structural Welding Code - Steel

4. AWWA C206, Field Welding of Steel Water Pipe

5. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances

6. AWWA C651, Disinfecting Water Mains

7. AWWA M9, Concrete Pressure Pipe

8. AWWA M11, Steel Water Pipe: A Guide for Design and Installation

9. AWWA M23, PVC Pipe: Design and Installation

10. AWWA M41, Ductile-Iron Pipe and Fittings

11. AWWA M45, Fiberglass Pipe Design

12. AWWA M55, PE Pipe – Design and Installation

13. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Exposed Piping Schedule: Comply with the pipe schedule as shown on the Drawings.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit layout drawings for all piping showing full details of piping, valves, hangers, supports, restraints, piping accessories, specials, and connections to existing pipes and structures. Piping system drawings shall, in general, be in a plan and section format and shall be drawn at sufficient scale(s) and detail to clearly show the components of each piping system, both for shop fabrication and for field installation and inspection.

2. Submit thrust restraint and piping system support design evaluations.

3. For all grooved end-piping systems, provide a detailed engineering analysis by the grooved end pipe-coupling manufacturer of each piping system as follows:

a. The grooved end pipe-coupling manufacturer shall review each pipe system and make recommendations to the CONTRACTOR for support of each pipe system.

b. The analysis shall be prepared and submitted in conjunction with the pipe support system analysis

required in Section 40 05 07, Hangers and Supports for Process Piping.

c. Analysis shall include the grooved end pipe coupling manufacturer's recommendation for location of flexible and rigid coupling as described herein. Show all anticipated locations, amounts and direction of pipe movements or deflections due to flexible joints under working or test pressures, as well as the locations and design details of all supports or braces necessary to control such movement and maintain straight piping alignment.

4. Certificates: Submit a certificate signed by manufacturer of each product certifying that the product conforms to applicable referenced standards.

5. Record Documents:

a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping work shall show actual location of all piping and appurtenances on a copy of the Drawings.

b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.

c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.

B. Product Data: Submit data on new or replacement equipment and parts.

C. Quality Assurance /Control Submittals:

1. CONTRACTOR shall submit documentation that all welders have been qualified in accordance with ASME Boiler and Pressure Vessel Code Section IX or American Welding Society Structural Welding Code D1.1, Section 5, whichever

is required. CONTRACTOR shall submit current certificates for the Project Representative's review.

2. Test Reports:

   a) Submit description of proposed testing methods, procedures, and apparatus.

   b) Submit test results for each system.

3. Submit certification of compliance with Reference Standards.

4. For grooved joint pipe, submit documentation demonstrating compliance with requirements regarding CONTRACTOR's ability to field cut and otherwise modify grooved joint pipe in accordance with the manufacturer's standards.

5. Disinfection: Submit description of forms of chlorine, dosages, and proposed methods of application to the Project Representative for acceptance, 7 days prior to disinfection.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Acceptance at Site:

1. Inspect all equipment and materials against approved Shop Drawings at time of delivery.

2. Equipment and materials damaged or not meeting the requirements of the approved Shop Drawings shall be immediately returned for replacement or repair.

B. Storage and Protection:

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.

2. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the manufacturer's instructions.

C. Handling:

1. Handle all pipe, fittings, specials and accessories carefully with approved handling devices and according to the manufacturer. Do not drop or roll material off trucks. Do not otherwise drop, roll or skid piping.

2. Avoid unnecessary handling of pipe.

3. Keep pipe interiors free from dirt and foreign matter.

4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	WARRANTY	(Not Used)
1.12	SYSTEM START UP	(Not Used)
1.13	INSTRUCTION OF OWNER'S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01	MANUFACTURERS	(Not Used)
2.02	EXISTING PRODUCTS	(Not Used)

2.03 MATERIALS

A. Piping Materials: Comply with appropriate piping specification and with the Pipe Schedule shown on the Drawings.

B. Water for test, flushing, disinfection, or otherwise used in the Work shall be provided at no cost to the OWNER and shall be free of contaminants.

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)

2.11 SOURCE QUALITY CONTROL

A. Clearly mark each pipe length, outlet, and fitting with designation complying with the Shop Drawings.

B. Paint or cast class designation on each pipe length or fitting 4 inches in diameter and larger.

C. Clearly mark material, type and rating on piping less than 4 inches in diameter at the factory.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Notify the Project Representative before proceeding if there is a conflict between the manufacturer's recommendations and the Contract Documents.

B. Notify the Project Representative of conflicts between piping systems and equipment or structures.

C. Do not proceed until all conflicts are rectified.

D. Store all grooved joint gaskets in a clean, heated and dry area.

3.03 PREPARATION (Not Used)
3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. General:

1. Install piping as shown, specified and as recommended by the manufacturer.

2. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:

a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41

b. Concrete Pipe: AWWA M9

c. Steel Pipe: ASME B31.3, ANSI/AWWA C206, AWWA M11

d. Thermoplastic Pipe: AWWA M23

e. Fiberglass Reinforced Plastic Pipe: AWWA M45

f. Polyethylene Pipe: AWWA M55

B. Piping:

1. Install straight runs true to line and elevation.

2. Install vertical pipe plumb in all directions.

3. Install piping parallel or perpendicular to building walls. Piping at angles and 45 degree runs across corners will not be accepted unless specifically shown.

4. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping to avoid ducts, equipment, beams, etc.

5. Install piping to avoid obstructing corridors, walkways, work areas, and like spaces. Provide minimum headroom clearance under all piping of 7 feet-6 inches unless otherwise shown.

6. Provide temporary caps or plugs at all pipe openings at the end of each day's work, and when otherwise requested by the Project Representative.

7. Verify all field dimensions before starting Work.

8. Cut pipe to field measurements unless otherwise approved by the Project Representative.

9. Piping shall be fabricated and installed as shown on the Drawings. Use of flange adapters, unit flanges, or sleeve couplings shall be acceptable only where shown on the Drawings or accepted by the Project Representative.

C. Joints:

1. General:

a. Make joints in accordance with the pipe manufacturer's recommendations and the requirements below. Flame cutting will not be allowed.

b. Cut piping accurate and square. Assemble without forcing or springing.

c. Ream all pipes and tubing to full inside diameter after cutting. Remove sharp edges on end cuts.

d. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.

e. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.

f. Thoroughly wire brush, wipe clean and dry all spigot-mating surfaces immediately before pipe is installed.

2. Threaded Joints:

a. Use standard right hand tapered full depth threads on steel piping.

b. Before installation, apply an approved joint compound to the male threads only.

c. Leave 3 pipe threads maximum exposed at each connection.

3. Solder Joints:

a. Pipe ends shall be cut square.

b. Ream or file pipe to remove burrs.

c. Clean and polish contact surfaces of joints.

d. Apply flux to both male and female ends.

e. Insert end of tube full depth into fitting socket.

f. Heat joint evenly.

g. Form continuous solder bead around entire joint circumference.

4. Flanged Joints: Use hexagon head nuts and bolts with clean and lubricated threads. Assemble flanged joints with gaskets and gasket compounds. Tighten flange bolts evenly.

5. Plastic Pipe Joints: Comply with approved pipe shop drawings and manufacturer's recommendations.

6. Welded Joints:

a. Comply with all applicable requirements of the appropriate section of the Code for Process Piping, ASME B31.3, and AWWA C206 for steel pipe and fittings.

7. Concrete Pipe Joints: Fill outside of joints with grout on all concrete pipe less than 24-inch diameter and fill inside and

outside of joints of all concrete pipe 24-inch diameter and larger in accordance with manufacturer's recommendations.

8. Grooved End Pipe Joints:

   a. Each joint in grooved end pipe systems shall be joined by either a rigid or flexible type coupling. Couplings are specified in Section 40 05 06, Piping Accessories.

   b. Rigid Couplings: Provide where shown on the Drawings and where recommended by the grooved end pipe coupling manufacturer and accepted by the Project Representative. At a minimum, rigid couplings shall be provided at the following locations:

      1) Provide rigid joints on horizontal and vertical pipe runs, except where otherwise specified or shown on the Drawings and in thermoplastic pipe systems.

      2) Adjacent to valves to prevent rotation of the valve during valve operation.

   c. Flexible Couplings:

      1) Provide flexible couplings at all thermoplastic (PVC) pipe joints where grooved end pipe couplings are indicated. Do not install rigid joint grooved end pipe couplings on PVC piping systems.

      2) Provide in limited locations in the piping system where shown on the Drawings, recommended by the grooved end pipe coupling manufacturer and accepted by the Project Representative.

      3) Provide flexible couplings at all vibrating equipment (pumps, for example) to absorb vibration. Two (2) flexible couplings, minimum shall be provided at each connection, and shall be installed with gaps such that vibration is permitted (that is, not fully compressed or

extended). Piping adjacent to such vibration-allowing couplings shall be braced so that the installed vibration gaps are maintained during testing and operation of the pipeline.

d. Provide for thermal expansion and thrust restraint of grooved end pipe systems.

e. Coupling Installation:

1) Install items in complete conformance with the approved shop drawings and the grooved end pipe coupling manufacturer's instructions.

2) Assure that the gaskets supplied are suited for the intended service.

3) Reject any gasket, which is dirty, scratched, nicked, blemished or otherwise defective.

f. Field Grooved Pipe Joints:

1) Field-grooved pipe shall be permitted only after the CONTRACTOR has demonstrated expertise in making such rolled grooves for a variety of pipe sizes to:

a) The coupling manufacturer's quality control representative.

b) The Project Representative

2) The CONTRACTOR's grooving equipment shall be of a type specifically designed for jobsite grooving, shall be in excellent working condition, and shall be capable of grooving the full range of anticipated diameters' wall thickness, and conditions.

3) The CONTRACTOR's grooving equipment shall be well secured and stable, and include integral pipe stabilizers. Pipe stands shall also be provided to securely support and align the

pipe at a point slightly beyond one half of the pipe length from the grooving tool.

4) The CONTRACTOR's job site grooving equipment shall be capable of providing grooved pipe ends meeting the tolerances required by the grooved end pipe coupling manufacturer or those specified below, whichever is more stringent.

a) Gasket Seat: +/- 0.03 inches, measured from the square cut pipe end.

b) Groove Width: +/- 0.03 inches; where a radius cut is required at the bottom of the groove (PVC, ductile iron, cast iron pipe for example), provide grooved end pipe coupling manufacturer's recommended radius cut.

c) Groove Diameter: Uniform groove depth for the entire pipe circumference. Plus, tolerance = +0.000. Minus tolerance range = -0.015 to -0.030 depending on pipe size.

d) End Flare (Where Applicable): Maximum increase beyond pipe outside diameter = 0.10 to 0.17 inches, depending on pipe size.

g. Provide independent supports for all valves, flowmeters, in-line pumps, or other items installed in grooved end joint piping systems to prevent rotation, slippage or deflection.

h. Comply with grooved end joint manufacturer's engineering analysis for locations, type and design of additional special braces, restraints and supports required for each grooved end joint piping system, in addition to those shown on the Drawings and otherwise required.

i. Refer to Section 09900, Painting, for special painting requirements for grooved end joint piping systems.

j. Whenever a grooved end pipe joint is disassembled - due to testing, repair or any other reason - the gasket shall be discarded and replaced with a new gasket of the same type, size, and service conditions.

D. Unions:

1. Install dielectric unions where dissimilar metals are connected except at bronze or brass valves installed in ferrous piping.

2. Provide a union downstream of each screwed end valve.

3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

E. Eccentric Reducers: Use eccentric reducers where shown and where air or water pockets would occur in mains because of reduction in pipe size.

F. Valves and Accessories:

1. Provide supports for large valves, flow meters and other heavy items.

2. Install floor stands as shown and as recommended by the manufacturer.

3. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by the manufacturer.

4. Provide steel sleeves where operating stems pass through floor. Extend sleeves 2 inches above floor.

5. Position valve operators as shown. When the position is not shown, install the valve so that it can be conveniently operated as reviewed by Project Representative. Avoid placing operators at angles to the floors or walls.

6. Position flow measuring devices so that they comply with the manufacturer's recommended straight upstream and downstream runs unless specific location dimensions are shown. Position flow measuring devices to avoid conflict with butterfly control valve discs.

7. See paragraph 3.05.C.8 for grooved end pipe joint requirements.

G. Transitions between Types of Pipe:

1. Provide all necessary adapters, specials and connector pieces when connecting different types and sizes of pipe or connecting pipe furnished by different manufacturers.

H. Restraints, Supports and Thrust Blocks:

1. Install restrained joints as shown, specified, recommended by manufacturer or otherwise required in the Drawings.

2. Provide concrete and metal cradles, collars, kickers, and blocks as shown or specified.

3. See paragraph 3.05.C.8. of this Section for grooved end pipe joint requirements.

I. Expansion Couplings:

1. Install expansion couplings in tension to facilitate their removal.

2. Set stretcher bolts for maximum allowable elongation of expansion coupling as recommended by the manufacturer.

3. Provide axial position guides to maintain alignment.

4. Provide a separate coupling for each expansion joint.

J. Provide expansion compensators specified in Section 40 05 06, Piping Accessories, where necessary to absorb expansion and contraction in heating lines as follows:

1. 30 feet on center for copper piping

2. 50 feet on center for steel piping

K. Adjustment: Adjust all parts and components as required to provide correct operation.

L. Fiberglass Reinforced Plastic and Thermoplastic Piping Supplementary Requirements:

1. All valves shall be supported independently of the piping system.

2. Use wide band supports as recommended by the manufacturer to minimize localized stresses.

3. Provide wearing material sleeve for piping passing through walls to prevent abrasion damage to piping.

4. Place anchors at elbows, valve locations and at bends in pipeline.

5. Space supports in accordance with the manufacturer's published values for the maximum design operating temperature of the pipe.

6. Use "U" clamps with wide band circumferential contact. Avoid all pressure contact with piping.

7. Use guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by manufacturer.

8. Use bellows with low axial force to take up pipe expansion. Provide anchors to restrain the expansion joint. Keep use of bellows joints to a minimum.

9. Flexible connectors may be used to absorb thermal movement as reviewed by the Project Representative.

10. Provide air chambers on all pump discharge lines to reduce hydraulic hammer. Provide flexible connectors to absorb vibration.

11. Install no pipe when temperature is less than 60°F except as otherwise recommended by manufacturer and reviewed by the Project Representative.

12. Expansion Joints: Install expansion joints in all PVC and CPVC piping systems, 3 inches and larger, as indicated on the Drawings and as required.

    a. Comply with the manufacturers' recommendations and procedures for selection, location and installation of expansion joints.

    b. Comply with manufacturers' requirements for anchorage and directional guides required for proper operation of expansion joints.

13. Grooved End Pipe Joints:

    a. General: See paragraph 3.05.C.8 for grooved end pipe requirements, including coupling installation.

    b. When valves, pumps and equipment are not available with grooved end connections, provide flanged joints or screwed union joints for PVC pipe only.

14. At pipe expansion joints, valves, flowmeters, equipment connections, etc., do not provide solvent welded joints. Provide joints, which allow simple and quick removal, replacement or maintenance of equipment.

M. Work Affecting Existing Piping:

1. Removing Existing Pipelines from Service:

    a. Notify Project Representative at least 48 hours prior to taking pipeline out of service.

    b. Pipelines shall not be removed from service unless specifically approved by the Project Representative.

2. Work on Existing Pipelines:

    a. Cut piping as shown or required using machines designed specifically for this work.

b. Install temporary caps or plugs to keep out all dirt, water and debris.

c. Provide all necessary adapters, fittings, pipe and appurtenances.

d. Comply with all applicable requirements herein for installing new pipe, making connections or modifications and for cleaning, testing, and disinfecting portions of existing piping modified or to which connections are made.

3.06 APPLICATION

A. Grooved and Shoulder pipe shall not be used for process piping and is limited in use to potable water systems.

3.07 CONSTRUCTION (Not Used)
3.08 REPAIR/RESTORATION (Not Used)
3.09 RE-INSTALLATION (Not Used)

3.10 FIELD QUALITY CONTROL

A. Site Tests:

1. General:

a. Test all piping as described in the applicable reference standards listed in paragraph 1.02.A and as specified herein.

b. Notify Project Representative at least 72 hours in advance of testing.

c. Provide all testing apparatus, including pumps, hoses, gages, and fittings.

d. Pipelines shall hold the specified test pressure for the designated period. Pressures are specified in the Pipe Schedule shown on the Drawings.

e. Repair and retest pipelines which fail to hold specified test pressures or which exceed the allowable leakage rate.

f. Test pressures specified apply at the lowest elevation of the pipeline section being tested unless otherwise noted.

g. Conduct all tests in the presence of the Project Representative.

h. The CONTRACTOR is responsible for all testing and shall pay all costs incurred during the specified testing including testing medium.

i. Pipe test pressures shall be as indicated in the Pipe Schedules shown on the Drawings.

j. Test representative composite section of each type of piping system before proceeding with remaining piping Work.

2. Pressure Test Procedure:

a. Ensure that all supports and restraint protection are securely in place.

b. Slowly fill section to be tested with water and expel all air. Install corporation cocks as necessary to remove air.

c. Apply test pressure for a 2-hour period and observe pressure gauge. Carefully check for leaks while test pressure is being maintained.

d. Visible leakage is not permitted in exposed piping systems. If test fails, the CONTRACTOR shall repair line and retest at no additional cost to OWNER.

e. Valves, pipe couplings, density and flow meters, pipe accessories and appurtenances associated with a given section of pipeline shall be tested with, and at the same pressure as, that section of pipeline.

Pressure relief valves shall be removed and their openings plugged during testing. Valves shall be tested at the scheduled pressure only for body rating. Drip tight shutoff valves shall only be tested to line working pressure. Where valves will not hold drip tight at test pressure, they shall not be used to isolate a section of line. Blind flanges shall be used in such a case.

f. Refer to specific piping section in Division 15 for other test procedures.

3. Testing of Drainage Pipe:

a. General:

1) Test all drainage piping installed under this Section.

2) Provide all testing apparatus required.

3) Conduct all tests in presence of the Project Representative.

b. Procedures:

1) Perform test on entire system or on individual sections as reviewed by the Project Representative.

2) Completely seal all openings except highest opening in system or section to be tested.

3) Completely fill with water and test with at least 10 feet of water above highest point.

4) Allow water to stand in system for at least 15 minutes. Inspect for and repair all leaks. Retest repaired sections.

B. Manufacturer's Field Service: Provide the services of a competent manufacturer's installation specialist when installation of specially fabricated piping begins.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Thoroughly clean and flush all piping prior to placing in service in a manner accepted by the Project Representative. Inspect inside of piping 24-inch diameter and larger and remove all debris, dirt and foreign matter.

B. Potable Water Piping Disinfection:

1. Standard: Conform to procedures described in AWWA C651. Use continuous feed method of disinfection unless alternative method is acceptable to the Project Representative.

2. Disinfect and test for disinfection all potable water piping.

3. Flush piping with water at 2 1/2 fps minimum velocity prior to disinfection.

4. Water for flushing, testing and chlorination will be at no cost to OWNER.

5. Chlorine shall be supplied by the CONTRACTOR.

6. All labor, material and equipment including chlorination taps and blow-off taps shall be furnished and paid for by the CONTRACTOR.

7. Bacteriological tests will be performed by the Project Representative. Certified laboratory test reports shall be available to the CONTRACTOR, if requested.

8. Chlorine Concentration:

a. Maintain chlorine concentration between 50 and 100 ppm for water entering the pipe. 25 ppm residual concentration shall remain after 24-hour retention period.

b. Repeat the operation as necessary to provide complete disinfection.

3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 40 05 06

PIPING ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:

1. The extent of piping accessories is shown on the Drawings.

2. The types of piping accessories include the following:

a. Sleeve couplings

b. Split-sleeve couplings

c. Flanged coupling adapters

d. Grooved and shoulder end pipe couplings

e. Expansion couplings - general

f. Expansion couplings - PVC

g. Expansion compensators - heating systems

h. Alignment guides

i. Repair parts and maintenance materials

B. Furnish all labor, materials, equipment, and incidentals required for piping accessories to install a complete and functional system.

C. Related Sections:

1. Section 09 91 10, Painting

2. Section 33 05 00, Buried Piping Installation

3. Section 40 05 05, Exposed Piping Installation

1.02 REFERENCES

A. Reference Standards:

1. American Society for Testing and Materials (ASTM) A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

3. ASTM A351/A35M-06, Standard Specification for Casting, Austenitic, for Pressure-Containing Parts

4. ASTM A395, Standard Specification for Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures

5. ASTM A536, Standard Specification for Ductile Iron Castings

6. ASTM A743/A743M-06 Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application

7. ASTM A744/A744M-06 Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service

8. American National Standards Institute (ANSI)

9. American Water Works Association (AWWA) C606, Grooved and Shouldered Joints

10. National Science Foundation (NSF) Standard 61, Drinking Water System Components – Health Effects

1.03 DEFINITIONS (Not Used)
1.04 SYSTEM DESCRIPTION (Not Used)

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit drawings and data for all piping accessories including instructions for installation in conjunction with the Shop Drawings required under Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Product Data: Submit manufacturer's data for all new or replacement equipment and parts.

C. Repair Parts and Maintenance Material: Submit a list of repair parts and maintenance material to be provided in accordance with paragraph 1.15 of this Section.

D. Grooved joint couplings and fittings shall be shown on the Drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Product Delivery, Storage, and Protection: Comply with Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)
1.11 WARRANTY (Not Used)
1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)

1.15 MAINTENANCE

A. Repair Parts and Maintenance Material: For each type of grooved coupling provided for this Contract, provide 2 spare couplings and 4 spare gaskets for each size, except for 16-inch and above, provide 1 spare coupling and 4 spare gaskets.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sleeve Couplings:

1. Dresser Industries
2. Smith-Blair, Inc.
3. Or approved equal

B. Split-Sleeve Couplings:

1. Victaulic Depend-O-Lok

C. Flanged Coupling Adapters:

1. Dresser Industries
2. Smith-Blair, Inc.
3. Victaulic Depend-O-Lok
4. Or approved equal

D. Grooved or Shoulder End Pipe Couplings:

1. Victaulic Company of America
2. Or approved equal

E. Expansion Couplings (Joints) - General:

1. Standard spool type, single arch by Mercer Rubber Co.
2. Standard spool type, single arch by Garlock, Inc.

3. Or approved equal

F. Expansion Couplings (Joints) - PVC:

1. Chemtrol, a Brand of Nibco

2. Or approved equal

G. Expansion Compensators - Heating Systems:

1. Senior Flexonics

2. Hyspan, Series 8500

3. Or approved equal

2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. Sleeve Couplings:

1. Minimum Wall Thickness: Comply with manufacturer's recommendations.

2. Minimum Length:

a. Pipe sizes up to 10 inches: 5 inches

b. Pipe sizes 10 inches to 30 inches: 7 inches

c. Pipe larger than 30 inches: 10 inches

3. Comply with manufacturer's recommendations for dimensions, size, spacing and materials for lugs, bolts, washers and nuts.

4. Design Criteria:

a. Pressure and Service: Same as connected piping.

b. Material of middle ring and followers: Steel

c. Gaskets: Comply with manufacturer's recommendations or as specified in specific piping section.

d. Bolts and Nuts:

1) Exposed: Galvanized, corrosion-resistant alloy steel.

2) Buried, submerged, or inside a vessel: 316 stainless steel.

5. Harnessing:

a. Harness couplings where shown and as required to restrain piping to test pressure.

b. Tie adjacent flanges with bolts of corrosion resistant alloy steel. A minimum number of 4 flanges required per coupling.

c. Provide flange mounted stretcher bolt plates as shown. Use manufacturer's material unless otherwise specified.

d. Tie bolts, stretcher bolt plates, threaded rod, and other miscellaneous hardware or fasteners shall be galvanized steel.

e. Where split sleeve couplings are used, end rings may be used for restraint in lieu of harnessing.

6. Coatings:

a. Coupling Interior: Factory applied.

1) General: Vinyl or coal tar enamel.

2) For potable water piping: Coating shall be approved for use in contact with potable water in accordance with NSF Standard 61.

b. Coupling Exterior: Comply with Section 09 91 10, Painting.

B. Split-Sleeve Couplings:

1. Minimum Wall Thickness: Comply with manufacturer's recommendations.

2. Standard Length:

a. Pipe sizes up to 4 inches: 5 inches

b. Pipe sizes 5 inches and 6 inches: 7.5 inches

c. Pipe sizes 8 inches to 84 inches: 10 inches

d. Pipe larger than 84 inches: 12 inches

3. Comply with manufacturer's recommendations for dimensions, size, spacing and materials for lugs, bolts, washers, and nuts.

4. Design Criteria:

a. Pressure and Service: Same as connected piping.

b. Material of end ring: Steel

c. Gaskets: Comply with manufacturer's recommendations or as specified in specific piping section.

d. Bolts and Nuts: Plated carbon steel

5. Coatings:

a. Coupling Interior: Factory applied.

1) General: Vinyl or coal tar enamel

2) For potable water piping: Coating shall be approved for use in contact with potable water in accordance with NSF Standard 61.

b. Coupling Exterior: Comply with Section 09 91 10, Painting.

C. Flanged Coupling Adapters:

1. Construction: 1 end flanged and 1 end sleeve or split-sleeve type coupling.

2. Pressure and Service: Same as connected piping.

3. Gasket: Comply with manufacturer's recommendations.

4. Bolts and Nuts: Galvanized, corrosion-resistant alloy steel.

5. Material: Cast Iron

6. Harnessing:

a. Steel Pipe:

1) Lock or harness all flanged coupling adapters, except as otherwise shown.

2) Coupling adapters through 12-inch nominal diameter may be harnessed with anchor studs.

3) Harness coupling adapters larger than 12-inch nominal diameter with tie rods.

b. Ductile Iron Pipe:

1) Harness adapters as shown, specified or otherwise required to restrain pressure piping.

2) Adapters 12-inch diameter or less:

a) Method: 1/2-inch minimum stainless steel anchor studs in anchor boss.

b) Number of Studs: Comply with manufacturer's recommendation for test pressure and service conditions.

3) Adapters larger than 12-inch diameter:

a) Method: Harness assembly by tying to adjacent flange or lugs on pipe with corrosion resistant alloy steel bolts.

b) Number of Bolts: Comply with manufacturer's recommendation for test pressure and service conditions. A minimum number of 4 bolts required per each adapter.

6. Coatings:

a. Coupling Interior: Factory applied.

1) General: Vinyl or coal tar enamel

2) Potable water piping: Coating shall be approved for use in contact with potable water in accordance with NSF Standard 61.

b. Coupling Exterior: Comply with Section 09 91 10, Painting.

D. Grooved or Shoulder End Pipe Couplings:

1. Product:

a. Basis of Design: Victaulic Company of America.

b. Where grooved-joint couplings are not specifically shown or indicated on the Drawings, grooved-joint couplings and fittings may be used in lieu of flanged or welded joints. Grooved joint product selection and intended use shall be verified as suitable for the intended service, in accordance with the coupling manufacturer’s latest published instructions.

c. Comply with coupling manufacturer's analysis as required in Section 40 05 05, Exposed Piping Installation, regarding flexible and rigid couplings. Couplings shall conform to the applicable requirements of AWWA C606.

d. Ductile Iron or Cast Iron Pipe:

1) Style 31 for flexible or rigid pipe and fittings 36-inch diameter and less.

2) Style 44 for collared or shouldered piping, fittings, valves and appurtenances as recommended by the coupling manufacturer.

e. Steel and Stainless Steel Pipe:

1) Style 77 for grooved pipe, flexible joint

2) Style 77S for stainless steel grooved pipe, flexible joint

3) Style 07 for grooved pipe, rigid joint.

4) Style 89, for stainless steel grooved pipe, rigid joints

5) Style 489, for stainless steel grooved pipe, rigid joints

6) Style 44 for collared or shouldered end piping, fittings, valves and appurtenances as recommended by the coupling manufacturer.

7) Advanced Groove System (AGS) Series couplings, sizes 14 inches through 24 inches, two (2) housings, wide width gasket. Victaulic Style W07 for rigid joints and Style W77 for flexible joints.

f. PVC Pipe:

1) Style 77 for flexible couplings

2) Style 72 for outlet couplings

3) Style 75 for flexible couplings

g. Copper Tube:

1) Style 606 for rigid couplings

h. Gaskets: Victaulic Flush-Seal type, having a short center leg which shall bridge the pipe ends and offer an initial seal on the leading edge of the pipe ends.

i. Adapters:

1) Style 341 for ductile iron pipe

2) Style 741 for steel, stainless steel, and PVC pipe

3) Style 441 for stainless steel pipe

2. General: Provide 1- or 2-piece construction with gasket, nuts, bolts and locking toggle or lugs to secure unit together.

3. Pressure and Service: Same as connected piping.

4. Gaskets:

a. General Use: EPDM (Grade E) or Nitrile (Grade T) Grade to suit the intended service.

b. Ductile Iron: Use gasket specifically designed for ductile iron pipe systems and specific service.

c. Air Main Service: Halogenated Butyl (Grade M)

d. Each gasket to have visual identifier of material type.

e. Assure that the gaskets supplied are suited for the intended service.

5. Housing:

a. Exposed Piping: Ductile Iron: ASTM A395 and A536. Stainless Steel: ASTM A351, A743, and A744 Grade CF-8M

b. Buried Piping: Ductile Iron, ASTM A395 and A536

6. Bolts and Nuts:

a. Material: Type 316 stainless steel

b. Use 2 or more track head, oval neck bolts.

7. Lubricant: Comply with manufacturers' recommendations.

8. Pipe preparation:

a. Conform to coupling manufacturer's requirements for grooved or shoulder joints using couplings specified herein.

9. Coating:

a. All couplings shall be hot dip-galvanized.

b. All couplings shall be field painted in accordance with Section 09 91 10, Painting.

10. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. Expansion Couplings (Joints) - General:

1. Construction:

a. Tube and cover: Synthetic or natural rubber.

b. Body:

1) Fabric Reinforcement: High quality cotton or synthetic fabric impregnated with rubber or other synthetic compounds to permit flexibility.

2) Metal Reinforcement: Wire or solid steel rings embedded in and bonded to the body rubber.

3) Arch: Single filled arch style, unless otherwise shown.

c. Retaining Rings:

1) Steel with hot dipped galvanized coating in accordance with ASTM A123.

2) Drilled to match flange drilling.

d. Flanges: Flat faced, ANSI Class 125 drilling.

e. Temperature: Capable of withstanding 200°F.

2. Restraints:

a. General: Restrain all expansion couplings, unless otherwise shown.

b. Materials:

1) Control Rods and Nuts:

a) Material: ASTM A307 Steel, hot dipped galvanized.

b) Number and Size:

(1) Comply with manufacturer's recommendation for system test pressure.

(2) Minimum of 2 required for each expansion coupling.

2) Control Rod Plates:

a) Provide 2 galvanized steel plates per loaded rod.

b) Provide 2 rubber or neoprene washers per loaded rod.

c) Drilling:

(1) 2 holes drilled to match flanged drilling.

(2) 1 hole drilled 1/8 inch larger than nominal stretcher bolt diameter.

(3) Stretcher Bolt Sleeve: Provide rubber pipe sleeve over the stretcher bolts to control compression of the coupling.

d) Washers: Rubber or neoprene

F. Expansion Couplings (Joints) - PVC:

1. Expansion joints shall be piston type units employing Teflon (no asbestos permitted) for sealing, PVC or CPVC material of construction; 6-inch travel (minimum).

2. Location: Comply with Section 40 05 05, Exposed Piping Installation.

G. Expansion Compensators - Heating Systems:

1. Type: Two-ply phosphor bronze seamless bellows.

2. Shrouds: Brass protective shrouds.

3. End Connections: Male and female solder end fittings or screwed ends with adapters for screwed to sweat ends.

H. Dielectric Connections:

1. Where a copper pipe is connected to steel or cast-iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions may be used instead of the specified insulating sections.

2. Manufacturers: Provide products of one of the following:

a. EPCO

b. Matco-Norca

c. Or approved equal

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)

2.10 FINISHES

A. Comply with Section 09 91 10, Painting.

B. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

2.11 SOURCE QUALITY CONTROL

A. Stamp, mark, or identify all couplings with the following:

1. Name of manufacturer

2. Date of manufacture

3. Operating design pressure at operating design temperature

4. Type of service

5. Manufacturer's part number

PART 3 EXECUTION

3.01	ACCEPTABLE INSTALLERS	(Not Used)
3.02	EXAMINATION	(Not Used)
3.03	PREPARATION	(Not Used)
3.04	ERECTION	(Not Used)

3.05 INSTALLATION

A. Comply with Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Adjust expansion joints as required to ensure that they will be fully extended when the ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which they are installed.

3.06 APPLICATION

A. Grooved and Shoulder pipe shall not be used for process piping and is limited in use to potable water systems.

3.07 CONSTRUCTION (Not Used)
3.08 REPAIR/RESTORATION (Not Used)
3.09 RE-INSTALLATION (Not Used)

3.10 FIELD QUALITY CONTROL

A. Comply with Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Comply with Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

3.13 DEMONSTRATION (Not Used)
3.14 PROTECTION (Not Used)
3.15 SCHEDULES (Not Used)

+ + END OF SECTION + +

SECTION 40 05 07

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes hangers, brackets, and related items for the supporting of all piping, valves and related equipment furnished under this contract.

B. Furnish:

1. Cast-in-place concrete supports, cradles, or blocking as required or shown on the Drawings and in compliance with Section 600 of the CMS.

2. Prefabricated supports, saddles, stanchions, rollers, or flange bolted pipe supports or hangars specifically designed for pipe support applications.

3. Special supports, brackets, stands, thrust bracing, and related metal fabrications where standard products are not available, or not applicable, or where such fabrications are indicated on the Drawings or described in a particular Section of the Project Manual. All such metal fabrications shall comply with the requirements of Section 05 50 00, Metal Fabrications.

C. Related Sections:

1. Section 05 50 01, Anchor Bolts, Expansion Anchors, And Concrete Inserts

2. Section 05 50 00, Metal Fabrications

3. Section 09 91 10, Painting

4. Section 40 05 05, Exposed Piping Installation

5. Section 40 05 06, Piping Accessories

1.02 REFERENCES

A. Reference Standards:

1. ASME B1.1, Unified Inch Screw Threads (UN & UNR Thread Form)

2. ASTM A36/A36M, Standard Specification for Carbon Structural Steel

3. ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings

4. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

5. ASTM A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

6. ASTM A668/A668M, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use

7. ASTM A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

8. ASTM E84, Standard Test Methods for Surface Burning Characteristics of Building Materials

9. Cincinnati City Codes

10. MSS SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture

11. MSS SP 69, Pipe Hangers and Supports - Selection and Application

12. Ohio Building Code

13. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Provide hangers, supports, and appurtenances for the piping systems shown on the Contract Drawings and specified.

B. Furnish standard and fabricated hangers and supports with necessary inserts, bolts, nuts, rods, washers, and other accessories.

C. Pipe support systems or components thereof shown on the Drawings may or may not be indicative of the complete support system required for a piping system. Any supports shown on the Drawings shall be coordinated with the pipe support system analysis required under paragraph 1.05 and be supplemented or modified accordingly. The pipe support system analysis and all devices required as a result of that analysis are included in the scope of this Section and shall be provided at no additional cost to the OWNER.

D. General Design Criteria:

1. Provide hangers and supports, which are adjustable.

2. Provide hangers, supports, braces and appurtenances, which will permit the disassembly of both the support and the piping system. In general, bolted friction or clamp type devices should be used, and totally welded hangers and supports, or hangers and supports which are welded to the pipe, will not be acceptable.

3. Provide hangers and supports, which will not obstruct, or create safety hazards within, normal walkways or traffic patterns.

4. Provide hangers, supports and appurtenances in locations, which will not obstruct routine access to, or operation of adjacent valves, equipment or components.

5. Design loading of hangers and supports shall be based on the total weight of pipe, fittings, valves, accessories, insulation and contents of the pipe supported and shall include forces caused by expansion, contraction and thrust due to pressure and temperature changes and all appropriate flow considerations.

6. Supports and hangers shall be sized to carry the calculated design loading times a minimum safety factor of 4. Allowances for vibration are included in the safety factor.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit drawings for all hangers, braces and supports required for a complete support system for each piping system including location, installation, material, loads or forces, and deflection of all hangers, braces and supports.

2. Analyze each pipe system for all loads, forces and deflections on the hangers and supports and their reaction forces transmitted to the structure to which they are attached. Comply with MSS SP 58 and MSS SP 69 for load ratings, materials, and installation.

a. Show all anticipated locations, amounts and directions of pipe movements or deflections under working or test pressures and temperatures.

b. Show locations and design details of all supports, braces, guides, etc., necessary to control movement and deflection and maintain straight and plumb piping alignment.

c. Provide complete engineering analysis of supports for all piping systems using grooved or shouldered couplings specified in Section 40 05 06, Piping Accessories.

1) Coordinate analysis with grooved or shouldered pipe coupling manufacturer's

recommendation required in Section 40 05 05, Exposed Piping Installation.

3. Provide drawings as follows:

a. Plans of all piping layouts at a scale of 1/4 inch equal to 1 foot, showing the location of each pipe hanger, support or brace. Provide details or cut sheets of each item, and provide a reference or key system.

b. Show, in section view, clearances beneath and around all pipes supported on beams, trapeze-type hangers, posts, etc. Verify that hanger or support location does not compromise clear and safe walking or working areas.

B. Product Data: Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of MSS SP 58 and MSS SP 69.

C. Quality Assurance/Control Submittals:

1. Design Calculations:

a. Supports and Hangers for Horizontal Pipe: Provide a table of each size and type line to be supported and list support spacing, which will be used. Reference spacing shown to MSS SP 69 and, where MSS SP 69 does not apply, provide additional specific load and beam calculations for pipelines.

b. Braces (kickers and rigid supports): Provide thrust and surge calculations to show design loads, and structural calculations to show brace resisting capabilities.

1.06 QUALITY ASSURANCE

A Regulatory Requirements:

1. Comply with applicable provisions of regulatory agencies below and others having jurisdiction.

a. Cincinnati City Codes

b. Ohio Building Code (OBC)

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver material in manufacturer's original packaging.

2. All material labels and/or tags will be intact and legible.

B. Storage and Protection:

1. Store materials in a secure location and to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:

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

1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	WARRANTY	(Not Used)
1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER’S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS (Not Used)
2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. Pipe Attachments: The following types of pipe attachments are acceptable for those types of piping systems shown on the Drawings:

1. Adjustable Steel Clevis: MSS SP 58, Type 1

2. Steel Three Bolt Pipe Clamp: MSS SP 58, Type 3

3. Steel Pipe Clamp: MSS SP 58, Type 4

4. Adjustable Swivel Pipe Ring: MSS SP 58, Type 6

5. Adjustable Steel Band Hanger: MSS SP 58, Type 7

6. Riser Clamp: MSS SP 58, Type 8

7. Long Clips: MSS SP 58, Type 26

8. Steel Pipe Covering Protection Saddle: MSS SP 58, Type 39

9. Insulation Protection Shield: MSS SP 58, Type 40

10. Pipe Saddle Support: MSS SP 58, Type 36

11. Pipe Stanchion Saddle: MSS SP 58, Type 37

12. Adjustable Roller Hanger/Roller Chair: MSS SP 58, Type 43

13. Single Pipe Roll Support Hanger: MSS SP 58, Type 41

14. Channel Type Pipe Support: Hot dip galvanized steel conforming to ASTM A1011 Grade 33, 1 5/8 inches by 1 5/8 inches by 12 gage minimum size, or approved equal. Provide fittings as required.

15. Pipe Support Bolted to Flange: Standon Model S89

16. Alignment Guides:

    a. Type: Steel spider with 4 guiding fingers and guiding cylinder with base.

    b. Manufacturer:

        1) Anvil International, Inc.

        2) B-Line Systems, Inc.

        3) Tri-State Industries

        4) Or approved equal

B. Structural Attachments: The following types of structural attachments are acceptable:

1. Side Beam Clamp: MSS SP 58, Types 20 and 27

2. Center I-Beam Clamp: MSS SP 58, Type 21

3. Welded Steel Bracket: MSS SP 58, Types 31 and 32

4. Side Beam Bracket: MSS SP 58, Type 34

5. Malleable Concrete Insert: MSS-SP 58, Type 18

C. Hanger Rod Attachments: Use as required to complete assembly:

1. Forged Steel Cleaves: MSS SP 58, Type 14

2. Adjustable Turnbuckle: MSS SP 58, Type 15

3. Forged Steel Weldless Eye Nut: MSS SP 58, Type 17

D. Miscellaneous Materials:

1. Bolts, Nuts and Fasteners: ASTM A307 Grade A, hot-dip galvanized.

2. Concrete supports or blockings shall conform to the requirements of Division 3, Concrete.

3. Concrete anchorage shall conform to the requirements of Section 05 05 01, Anchor Bolts, Expansion Anchors, and Concrete Inserts.

4. Grout shall be non-shrink, non-metallic type, conforming to the requirements of Section 600 of the CMS.

5. Metal fabrications shall conform to Section 05 50 00, Metal Fabrication.

E. Chemical Piping Systems:

1. All pipe supports shall be glass fiber-reinforced plastic with a flame spread rating of 25, in accordance with ASTM E84.

2. Materials shall be manufactured by either the pultrusion or extrusion process.

3. All pipe supports shall have a surface veil over 100% of the surface which, along with a filler system, shall protect against degradation from ultra-violet light.

4. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance.

5. All-thread rods and fasteners shall be galvanized steel.

6. Manufacturers: Provide products from 1 of the following:

a. Unistrut Company

b. Or approved equal

2.04 MANUFACTURED UNITS (Not Used)
2.05 EQUIPMENT (Not Used)
2.06 COMPONENTS (Not Used)

2.07 ACCESSORIES

A. Hanger rods shall be made from ASTM A575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:

1. Concrete inserts shall be MSS SP 58 malleable Type 18.

2. Concrete inserts shall be of the continuous type capable of supporting equipment weight per ASTM A-325 standards.

C. Steel Beam Clamps:

1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58 type appropriate for the application and acceptable to the Owner or Owner's Representative.

D. Inserts for Pipe Insulation:

1. Insulated pipe, larger than 1 1/2 inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend 2 inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6 inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.

E. Brackets:

1. Brackets for wall mounting shall conform to MSS SP 58 Type 32 for medium-welded steel brackets, Type 33 for heavy-welded steel brackets, and Type 34 for side beam support.

F. Pipe Roll:

1. To provide for pipe expansion, pipe shall be supported on adjustable malleable or steel pipe rolls.

G. Fabricated Pipe Rack:

1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.08 MIXES (Not Used)

2.09 FABRICATION (Not Used)

2.10 FINISHES

A. Shop/Factory Finishing:

1. Steel Items: Hot-dip galvanized unless otherwise specified or shown on the Drawings.

2. Steel or malleable iron materials used for the support of copper piping:

a. Furnish copper plating, or

b. Hot dipped galvanized finish with 40-mil thick PVC coating securely bonded to all hanger or support components which will contact copper pipe.

3. Painting: Comply with Section 09 91 10, Painting.

2.11 SOURCE QUALITY CONTROL

A. Components of hangers and supports shall conform to the following:

1. Materials:

a. Bolts: ASTM A307, latest edition, Grade A, unless otherwise specified below.

b. Forgings: ASTM A668, latest edition.

c. Ferritic Malleable Iron: ASTM A47, latest edition.

d. Rods and Bars: ASTM A575, latest edition.

e. Threads: Unified Screw Threads, Class 12A and 2B, ASME B1.1.

f. Structural Steel: ASTM A36, latest edition.

g. Anchorage: Conform to the requirements of Section 05 05 01, Anchors Bolts, Expansion Anchors, and Concrete Inserts.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions: Examine the conditions under which the Work is to be installed and notify the Owner's Representative, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Begin no work without submittal receiving an acceptable disposition and Owner's Representative notification.

B. Field measure the proposed installation to assure a proper installation.

3.04 ERECTION (Not used)

3.05 INSTALLATION

A. Hangers and supports shall meet with the following requirements:

1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.

2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1 inch between pipe and other work.

3. Install hangers or supports at all locations where pipe changes direction.

4. All hangers and supports shall be capable of adjustment after placement of piping.

5. Different types of hangers or supports shall be kept to a minimum.

6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.

7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.

8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.

9. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one half of the values specified for steel pipe.

10. Plastic pipe at temperature greater than 130ºF shall be continuously supported in a metal cradle or tray.

11. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.

12. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:

1. $\Delta L = L \times \Delta T \times \alpha$.

a. Where ΔL = pipe length change (inches).

b. L = pipe length between anchors (inches).

c. ΔT = 100 (°F)

d. α = coefficient of thermal expansion (inches/inches/°F).

2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.

C. Pipe, hanger and coupling manufacturers shall review the pipe support system and make recommendations to the CONTRACTOR for every application and piping system. CONTRACTOR shall provide support system as recommended by the manufacturers in accordance with the accepted pipe support system analysis required in subparagraph 1.05.C of this Section, and as specified.

D. Restrain, block, brace, support, or suspend pipe and fittings to prevent displacement, vibration, sagging, warping, deformation, or failure of piping and fittings while allowing for expansion and contraction.

E. Provide all necessary miscellaneous steel, inserts, anchors, and concrete to support and anchor piping.

F. All piping supports shall be anchored with materials compatible to piping and the supporting materials.

G. Allow for piping expansion and contraction when placing anchors and supports.

H. Provide anchors at locations shown on the Drawings, specified or otherwise required. Anchors shall be of sufficient thickness and strength to prevent any movement of the pipe at the anchorage point. Securely fasten anchors directly to the concrete or steel construction or indirectly through structural framing. For piping containing a heating medium, where anchorage is not shown, adhere to the following as a minimum:

1. Anchor horizontal runs over 50 feet at midpoint to allow expansion toward ends. Anchor intervals shall not exceed 30 feet.

2. Provide alignment guides, spaced according to expansion compensator manufacturer's recommendations, where expansion compensators (couplings) are used. Comply with Section 40 05 06, Piping Accessories, and Section 40 05 05, Exposed Piping Installation, for expansion compensators.

I. Supports and Hangers for Horizontal Piping:

1. Where the exact location of piping is not shown on the plans, run piping in groups where practicable and generally parallel to building wall. Provide 1-inch minimum clearance between piping, pipe insulation, and other work.

2. For new concrete work, accurately locate inserts for hangers and hanger rods in forms before concrete is placed. Fasten embedded items securely to prevent movement during concrete placement.

3. Provide concrete supports as shown on the drawings in compliance with Division 3, Concrete.

4. All hangers and support units shall provide adjustment of piping after placement.

5. Install all hangers and supports to allow free expansion and contraction of the pipe.

6. For support of rods, hangers, and brackets of piping 24-inch and smaller refer to applications within Section 05 05 01, Anchor Bolts, Expansion Anchors, and Concrete Inserts, for selection criteria of anchors and inserts. Design to carry 100% of the full load, hanger and/or bracket and pipe load plus required safety factor in compliance with Section 05 05 01.

7. For piping larger than 24 inches, refer to the Drawings.

8. Install hangers and support units as recommended by manufacturer.

9. Locate hangers or supports immediately adjacent to any change in piping direction or elevation, and on both sides of valves, couplings, heavy fittings, flowmeters, equipment, etc.

a. On piping systems using grooved or shoulder couplings, provide independent support of valves, equipment, flowmeters, and similar heavy equipment in order to prevent rotation due to operating torque or normal equipment/pipe vibration.

10. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended therefrom.

11. When hangers are used to support insulated piping with vapor barriers, provide shields conforming to MSS SP 58, Type 40.

12. When hangers are used to support insulated piping without vapor barriers, provide saddles conforming to MSS SP 58, Type 39.

13. Prevent contact between dissimilar metals when supporting copper pipe by using steel or iron pipe hangers and devices coated with material that will not react with copper as specified in paragraph 2.10 of this Section.

14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or PVC or vinyl tape at points of contact. All ferrous pipes shall be supported by (galvanized) steel pipe attachment.

15. Hangers shall be suspended from other piping only where shown on the Drawings.

16. Chain wire, strap, or perforated bar hangers shall not be used to hang pipe.

17. Size hanger rods according to the schedule below, unless otherwise shown on the drawings.

Nominal Pipe Size (inches)	Rod Diameter (inches)
1/2 through 4	3/8
6 and 10	1/2
12 and 14	5/8
16 and 18	1

20 and 24	1-1/8
over 24	See Drawings

18. Space supports and hangers for all piping no farther apart than shown below, unless otherwise shown on the Drawings:

    a. Copper Tube:

        1) 2 inches or smaller: 6 feet on center

        2) 2 1/2 inches: 8 feet on center

    b. Steel Pipe:

        1) 1 inch or smaller: 6 feet on center

        2) 1 1/4 inches to 6 inches: 8 feet on center

        3) 8 inches and larger: 10 feet on center

    c. Ductile or Cast-Iron Pipe: 2 supports per length between joints or couplings.

    d. Plastic Pipe: One-half the values specified for steel pipe, unless the manufacturer, or appropriate standard or reference document recommend a shorter span for the given pipe material and conditions of installation. Plastic pipe at temperatures greater than 130°F shall be continuously supported in a metal cradle or tray.

J. Supports for Vertical Piping:

1. Provide vertical support as shown on the Drawings, specified and otherwise recommended by pipe support analysis.

2. Where vertical piping smaller than 4-inch size passes through floors, ceilings, or roofs, provide riser clamp providing solid bearing on steel sleeve. Avoid excessive compression on plastic piping.

3. For insulated piping passing through floors, provide stand-offs on piping to prevent contact with wall sleeve.

K. Restraints:

1. Provide braces, kickers, rigid supports, thrust brackets, base bends with support pipe, concrete brackets, etc. as required to maintain system equilibrium.

2. In some cases, restraints for piping systems may not be indicated or shown in detail. Comply with the requirements of this section for all piping systems.

L. Allow clearances for expansion and contraction of piping.

M. Provide all necessary supports, angle iron stands, miscellaneous steel, inserts, anchor bolts and hangers for all equipment and piping furnished under this Contract.

N. Assemble all piping in such a manner to prevent any movement during operation.

O. Provide bolted connections for field connections of pipe hanger support system. Field welding shall not be allowed.

P. Support plastic, fiberglass or PVC pipes and equipment in accordance with the piping manufacturer's requirements, including all special shields, saddles, plastic coatings, pipe wrapping, or similar protection against abrasion or damage to the pipe components.

Q. Clearance: Install no support, hanger, brace, etc., where it will project into normal walkways or encroach on normal safe headroom allowances (6 feet-8 inches minimum), or otherwise present a blockage or safety hazard to normal work activities at the Pump Station.

R. Field cutting or drilling of galvanized steel components should be avoided. Do not use flame torches to cut or provide holes in hangers or supports.

1. When field cutting or drilling of galvanized surfaces cannot be avoided, immediately brush clean all welds, cut edges and holes with a wire brush (or blast clean) and apply 2 heavy coats of Zinc-rich paint as described in Section

09900, Painting. Do not allow bare metal to remain exposed for periods of time greater than 12 hours.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. Remove and replace any damaged items, which are found to be defective after installation.

B. Patch or replace any damage caused by the installation of the piping supports.

C. Acceptance and Service:

1. Acceptance:

a. Bring all piping systems up to operating pressures and temperatures.

b. Cycle systems to duplicate operating conditions.

2. Service:

a. Furnish all labor and materials to readjust and correct faults with hangers and supports for the piping systems installed.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Clean and maintain the Work and its immediate area until acceptance of the Owner's Representative.

3.13 DEMONSTRATION (Not Used)

3.14	PROTECTION	Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 40 05 09

WALL AND FLOOR PIPES AND PIPE SLEEVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:

1. Various wall and floor pipes and pipe sleeve materials for piping systems including mechanical/process, plumbing, and heat, ventilating, and air conditioning systems.

B. Furnish all labor, material, equipment, and incidentals as shown and specified to install complete and functional systems.

C. Related Sections:

1. Section 07 92 00, Joint Sealants

2. Section 09 91 10, Painting

3. Section 33 05 00, Buried Piping Installation

4. Section 40 05 05, Exposed Piping Installation

5. Section 40 05 10, Mechanical Pipe Seals

1.02 REFERENCES (Not Used)
1.03 DEFINITIONS (Not Used)
1.04 SYSTEM DESCRIPTION (Not Used)

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit detailed drawings and data for all wall and floor pipes and wall and floor sleeves. Coordinate and submit

with Shop Drawings required for all piping systems under Sections 33 05 00, Buried Piping Installation, 40 05 05, Exposed Piping Installation, and 40 05 10, Mechanical Pipe Seals.

B. Products: Submit manufacturer's data for all new or replacement equipment and parts.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials in manufacturer's original packaging.

2. All material labels or tags shall be intact and legible.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)
1.11 WARRANTY (Not Used)
1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)
1.15 MAINTENANCE (Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS (Not Used)
2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. General:

1. All pipe dimensions are for nominal inside diameter, excluding steel pipe 14 inches in diameter and larger, which is outside diameter dimensions.

B. Materials:

1. Wall and Floor Pipes:

a. Material: Same as specified for the piping connected to the wall or floor pipe, unless otherwise shown or approved by the Owner's Representative.

b. End Connections: As shown or approved.

c. Thickness: Same as specified for the connecting piping unless otherwise shown or approved.

d. Collar: Provide collar integrally cast or continuously welded to pipe on both sides of collar about wall and floor pipe, at mid-point of wall or slab for anchorage, and watertightness.

e. Wall and floor pipes shall finish flush with wall or floor face unless otherwise shown (see exceptions for floor pipes in subparagraphs 3.05.B.2 and 3 of this Section).

f. Flanged ends and mechanical joint bells shall be drilled and tapped for studs. Provide studs of same material as bolting material on connected piping. Submerged and buried studs shall be of Type 304 stainless steel.

2. Sleeves in cast-in-place concrete walls and floors:

a. Sleeve material shall be one of the following unless otherwise shown:

1) Ductile Iron

2) Cast Iron

3) Schedule 40 galvanized steel

4) Thermoplastic Sleeves for Non-Fire Rated Walls Only: Century-Line high impact thermoplastic sleeves by PSI, or approved equal. Thermoplastic sleeves shall not be used in floors.

b. Collar: Provide collar continuously welded to sleeve on both sides of collar or integrally cast with the sleeve at mid-point of wall or slab for anchorage and watertightness.

3. Sleeves in walls other than cast-in-place concrete:

a. Sleeve material shall be one of the following unless otherwise shown:

1) Schedule 40 galvanized steel

2) For carrier pipe sizes less than 4 inches in diameter through non-fire rated walls only, schedule 40 PVC sleeves may be used.

4. Wall Pieces for Concrete Pressure Pipe: Provide suitably designed and fabricated wall pieces where shown on the Drawings. Fabricate from steel and provide cement mortar lining and a middle flange to serve as a water stop.

5. Wall, Floor and Ceiling Plates:

a. Bare pipes passing through walls, floors and ceilings in finished rooms: provide escutcheon plates of cast brass or cast iron nickel plated, hinged with set screws.

b. Insulated pipes passing through walls, floors and ceilings in finished rooms: provide plated escutcheon plates of 18-gage steel.

6. Mechanical Seals: Provide link type mechanical seals where shown or specified, in accordance with Section 40 05 10, Mechanical Pipe Seals.

C. Material Schedule:

1. Size sleeves to provide annular space as follows:

Pipe Size (inches)	Sleeve ID Minus Pipe or Insulation OD (inches)
Less than 2	1/2 to 3/4
2 to 4	3/4 to 1 1/4
6 to 12	1 1/4 to 2
Over 12	2 to 3

2. Where mechanical seals are shown or specified, provide sleeves of suitable inside diameter for the effective working range of the mechanical seal.

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)

2.11 SOURCE QUALITY CONTROL

A. Performance: All work shall be performed by a firm experienced, properly manned and tooled in the work specified.

PART 3 EXECUTION

3.01	ACCEPTABLE INSTALLERS	(Not Used)
3.02	EXAMINATION	(Not Used)
3.03	PREPARATION	(Not Used)
3.04	ERECTION	(Not Used)

3.05 INSTALLATION

A. Wall and Floor Pipes: Install as shown on reviewed Shop Drawings.

1. All piping shall be properly supported to prevent any movement when in service.

2. Thoroughly plan the installation prior to placing any piping.

3. Do not install wall and floor pipes and pipes through structural members unless specifically shown.

B. Sleeves:

1. Use sleeves wherever pipes pass through walls, partitions, floors and roofs unless otherwise shown.

2. All sleeves through floor slabs in process areas and areas which are frequently wet, or hosed down shall extend a minimum of 4 inches above finished floor.

3. All sleeves through floor slabs in architecturally finished areas shall extend 1/2-inch above finished floor.

4. Anchor sleeves to concrete and masonry walls as shown. Steel sleeves may be welded to reinforcing steel at CONTRACTOR's option.

5. Except where mechanical seals provided, caulk and seal annular space between pipe and sleeve with material complying with Section 07 92 00, Joint Sealants. Provide gastight seal of sleeves in hazardous areas such as chlorine storage and chlorine equipment.

6. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.

7. No pipe joints, fittings or valves shall be permitted within the sleeve.

8. Install sleeves through walls flush with each face.

9. Ensure that sleeves are not damaged or moved during placement of concrete.

10. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.

11. Size sleeves to provide annular space as shown in table in subparagraph 2.03.C. of this Section.

C. Shop prime cast wall and floor pipes and wall sleeves in accordance with Section 09 91 10, Painting.

D. Install wall and ceiling plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)
3.10	FIELD QUALITY CONTROL	(Not Used)
3.11	ADJUSTING	(Not Used)

3.12 CLEANING

A. Remove and replace any damaged items, which are found to be unsatisfactory after installation.

B. Clean all debris from sleeves and the immediate area of the installation.

C. Maintain the contracted installation in a clean undamaged condition until acceptance by the Owner’s Representative.

D. Install wall and ceiling plates in accordance with the manufacturer’s recommendations and approved Shop Drawings.

3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 40 05 10

MECHANICAL PIPE SEALS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:

1. All pipes or conduits passing through sleeves or cored openings in exterior walls or walls subject to hydrostatic pressure shall be sealed at each face of the wall, unless specifically shown otherwise.

2. All pipes or conduits passing through floor, roof or interior wall sleeves or cored openings shall be sealed at one face only, unless specifically shown otherwise.

3. Included in this Section are pipes, conduits including round electrical ducts. These are all referred to as pipes in the balance of this Section.

B. Furnish all labor, materials, equipment, and incidentals required to install Mechanical Seals. The seals shall provide air and water tightness as well as electrical insulation, between the pipe or conduit and the wall or floor opening.

C. Coordination:

1. Review installation procedures under other contracts and coordinate with other contractors the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings and panels constructed by such other contractors.

a. Provide other contractors with detailed plans or sketches of the locations of the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons as may be required.

b. Keep informed of the construction where floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons are to be installed. Install the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons in such a manner and within such time periods as will not delay the work of the other contractors.

D. Related Sections:

1. Section 33 05 00, Buried Piping Installation

2. Section 40 05 05, Exposed Piping Installation

1.02 REFERENCES

A. Reference Standards:

1. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus

2. ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION (Not Used)

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit schedule showing sleeve or core location and size, pipe size, link make, model, size, and number of links per seal.

B. Product Data: Submit manufacturer's data for all new or replacement equipment and parts.

1.06 QUALITY ASSURANCE (Not Used)

1.07	DELIVERY, STORAGE AND HANDLING	(Not Used)
1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	WARRANTY	(Not Used)
1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER'S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURER

A. See paragraph 2.03 below.

2.02 EXISTING PRODUCT (Not Used)

2.03 MATERIALS

A. General Use:

1. Manufacturer/Product:

a. Link-Seal, Service Designation S-316 (corrosive service), by PSI

b. Or approved equal

2. Sealing Element: ASTM D2000 EPDM rubber

3. Bolts and Nuts: Type 316 stainless steel

4. Pressure Plate: Glass reinforced nylon polymer

B. High Temperature Applications (Where specifically called for on Drawings) and 1-Hour Fire-Rated Wall Penetrations:

1. Manufacturer/Product:

a. Link-Seal, Service Designation T (high temperature service)

b. Or approved equal

2. Sealing Element: ASTM D2000 Silicone rubber

3. Bolts and Nuts: Carbon steel coated with a 2-part system consisting of zinc-dichromate plating covered by an organic coating. The fastener system shall be capable of passing a 1000-hour salt spray test per ASTM B117.

4. Pressure Plates: Zinc-dichromate plated steel

5. Service Range: -67°F to +400°F.

C. Fire Rated Wall Penetrations (3 hour rating or less but greater than 1 hour rating):

1. Manufacturer/Product:

a. Link-Seal, Service Designation FD/FS (fireseals) double seal

b. Or approved equal

2. Sealing Element: ASTM D2000 Silicone rubber

3. Bolts and Nuts: Carbon steel coated with a 2-part system consisting of zinc-dichromate plating covered by an organic coating. The fastener system shall be capable of passing a 1000-hour salt spray test per ASTM B117.

4. Pressure Plates: Zinc-dichromate plated steel

5. Service Range: -67°F to +400°F

D. Seals shall be sized in accordance with manufacturer's recommendations based upon pipe size and opening size.

2.04 MANUFACTURED UNITS (Not Used)
2.05 EQUIPMENT (Not Used)

2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)
2.11	SOURCE QUALITY CONTROL	(Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions:

1. Verify that sleeved or cored opening and pipe surface are sufficiently clean and smooth so as to provide adequate sealing surfaces.

2. Correct surface irregularities before proceeding further.

3.03	PREPARATION	(Not Used)
3.04	ERECTION	(Not Used)

3.05 INSTALLATION

A. Install seals in accordance with manufacturer's recommendations.

B. Tighten bolts uniformly and according to the manufacturer’s installation instructions to expand sealing elements and provide a positive seal between the pipe and the sleeve or cored concrete.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. Comply with Sections 33 05 00, Buried Pipe Installation, and 40 05 05, Exposed Pipe Installation.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Comply with Sections 33 05 00, Buried Pipe Installation, and 40 05 05, Exposed Pipe Installation.

3.13 DEMONSTRATION (Not Used)
3.14 PROTECTION (Not Used)
3.15 SCHEDULES (Not Used)

+ + END OF SECTION + +

SECTION 40 05 31.13

THERMOPLASTIC PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes thermoplastic systems, which include polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), and ultra high molecular weight high density (UHMWHD) Polyethylene pipe.

B. Furnish all labor, materials, equipment, accessories, appurtenances, and incidentals required for thermoplastic pipe systems.

C. The extent of thermoplastic piping is shown on the Drawings.

D. Related Sections:

1. Section 33 05 00, Buried Piping Installation

2. Section 40 05 05, Exposed Piping Installation

3. Section 40 05 06, Piping Accessories

1.02 REFERENCES

A. Reference Standards:

1. ANSI B1.2, Gages & Gaging For Unified Screw Threads

2. ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

3. ASTM D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

4. ASTM D1598, Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

5. ASTM D1599, Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

6. ASTM D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

7. ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

8. ASTM D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

9. ASTM D2122, Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

10. ASTM D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

11. ASTM D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

12. ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

13. ASTM D2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

14. ASTM D3311, Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns

15. ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

16. ASTM F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

17. ASTM F439, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

18. ASTM F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

19. ASTM F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

20. AWWA C901 ,Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch (13 mm) Through 3 inch (76 mm), for Water Service

21. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 inches (100 mm) Through 63 inches (1,600 mm), for Water Distribution and Transmission

22. NSF 61 Drinking Water System Components – Health Effects

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Service Conditions: Handle liquids expected in the stormwater pump station as shown on the Drawings or as specified.

2. Design Loads: Those imposed by the service conditions as shown on the Drawings or as specified.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit drawings and manufacturer's data showing details of each piping system to include material composition of pipe and fittings, pressure ratings, nominal size and wall dimensions, fittings and interfacing with equipment and appurtenances in conjunction with the Shop Drawings

required under Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

B. Product Data: Submit manufacturer's data on all new or replacement equipment, parts, and piping.

C. Quality Assurance/Control Submittals: Comply with Section 33 05 00, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, and the following:

1. Submit certificates of compliance with reference standards.

1.06 QUALITY ASSURANCE (Not Used)

1.07 DELIVERY, STORAGE AND HANDLING

A. Product Delivery, Storage, and Protection: Comply with Section 33 05 00, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)
1.11 WARRANTY (Not Used)
1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)
1.15 MAINTENANCE (Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. UHMWHD Polyethylene Piping:

1. Performance Pipe, A Division of Chevron Phillips Chemical Company, DriscoPlex 4100

2. Or approved equal

2.02 EXISTING PRODUCTS (Not Used)

2.03 MATERIALS

A. Polyvinyl Chloride (PVC) Piping:

1. Pipe and Fitting Materials:

a. Standard: ASTM D1784

b. Type: Type I, Grade 1, rigid (12454-B)

2. Pipe:

a. Standard: ASTM D1785

b. Designation: PVC 1120

c. Wall Thickness: Schedule 80

d. Working pressure: 150 psi

3. Joints:

a. General: Join pipe using one of the methods listed below as shown on the Drawings, scheduled or otherwise specified. If not indicated, provide grooved end pipe with flexible couplings for all joints in pipe system 3 inches or greater in diameter.

1) Flanged fittings

2) Threaded fittings

3) Solvent cement fittings

4) Grooved end pipe flexible couplings

b. Flanged Joints:

1) Use flanges joined to pipe by solvent cementing.

2) Flange Drilling and Dimensions: Comply with ANSI B16.1.

3) Flange Gaskets: EPDM full face

4) Bolts and Nuts: Type 316 stainless steel

c. Threaded Joints:

1) Taper Pipe Threads: ANSI B1.2

2) Joint Preparation: Teflon tape

d. Solvent Cement Joints:

1) Primer and Solvent Cement: ASTM D2564.

e. Grooved End Pipe Joints (For PVC Pipe 3 inches and larger in Diameter):

1) General: Install piping system using grooved pipe with square cut ends and mechanical pipe couplings with a central cavity design pressure-responsive gasket.

2) Groove Type: Roll or as recommended by the grooved end pipe coupling manufacturer.

3) Pipe Preparation: Comply with applicable requirements of grooved end pipe coupling manufacturer's recommendations and requirements.

4) Couplings:

a) Material and product as specified in Section 40 05 06, Piping Accessories.

b) Type and Location: To be as recommended by coupling manufacturer

as required in Section 40 05 05, Exposed Piping Installation.

5) At valves, pumps and equipment not available with grooved or shouldered pipe end joint construction provide joints that allow for quick joint disassembly for simple removal of item from piping system. Joint must be compatible with intended piping system design and submitted for approval.

4. Fittings:

a. Socket-Type:

1) Standard: ASTM D2467

2) Wall Thickness: Schedule 80

3) Designation: PVC I

b. Threaded Type:

1) Standard: ASTM D2464

2) Wall Thickness: Schedule 80

3) Designation: PVC I

5. Piping Accessories:

a. Refer to Section 40 05 06, Piping Accessories.

b. Expansion Joints:

1) Type: Comply with the requirements of Section 40 05 06, Piping Accessories.

2) Location: Comply with the requirements of Section 40 05 05, Exposed Piping Installation.

B. Chlorinated Polyvinyl Chloride (CPVC) Piping:

1. Pipe and Fitting Material:

a. Standard: ASTM D1784

b. Type: Type IV, Grade 1, rigid (23447-B)

2. Pipe:

a. Standard: ASTM F441

b. Wall Thickness: Schedule 80

3. Joints:

a. General: Join pipe sections using one of the methods listed below as shown on the Drawings, scheduled or otherwise specified. If not indicated, provide grooved end pipe with flexible couplings for all joints in pipe system 3 inches or greater in diameter.

1) Flanged fittings

2) Threaded fittings

3) Solvent cement fittings

4) Grooved end pipe flexible couplings

b. Flanged Joints:

1) Use flanges joined to pipe by solvent cementing.

2) Flange Drilling and Dimensions: Comply with ANSI B16.1.

3) Flange Gaskets: EPDM full face

4) Bolts and Nuts: Type 316 stainless steel

c. Threaded Joints:

1) Taper pipe threads, ANSI B1.2

2) Joint Preparation: Teflon tape

d. Solvent Cement Joints:

1) Primer and Solvent Cement: ASTM F493.

e. Grooved End Pipe Joints: Comply with subparagraph 2.03.A.3.e. of this Section, and the grooved end pipe coupling manufacturer's recommendation for CPVC pipe.

4. Fittings:

a. Socket Type:

1) Standard: ASTM F439

2) Wall Thickness: Schedule 80

3) Designation: CPVC

b. Threaded Type:

1) Standard: ASTM F437

2) Wall Thickness: Schedule 80

3) Designation: CPVC

5. Piping Accessories:

a. Refer to Section 40 05 06, Piping Accessories.

b. Expansion Joints:

1) Type: Comply with the requirements of Section 40 05 06, Piping Accessories.

2) Location: Comply with the requirements of Section 40 05 05, Exposed Piping Installation.

C. UHMWHD Polyethylene Piping:

1. Pipe Material:

a. Standards:

1) ASTM D3350

2) AWWA C 906 or C 901 for potable water lines.

3) NSF standard 61 for potable water lines.

b. Cell Classification: PE 345464 C

c. PPI Designation: PE 3408

d. Melt Flow: Less than 0.11 grams per 10 minutes with method ASTM D1238, Condition F.

e. Environmental Stress Crack Resistance: Exceed 5000 hours, ASTM D1693, Condition C.

f. Wall Thickness: SDR 11

2. Joints: Butt fusion

3. Piping Accessories: Refer to Section 40 05 06, Piping Accessories.

D. Drain, Waste and Vent (DWV) Pipe:

1. Material: PVC-DWV pipe shall be manufactured in accordance with ASTM D1784. Unless otherwise shown or specified, PVC-DWV pipe shall be:

a. Type, Grade: Type 1, Grade 1

b. Schedule: Schedule 40

c. Color: White

2. Fittings: Fittings shall be manufactured in accordance with ASTM D2665 and ASTM D3311.

a. Solvent Weld

b. Spigot

3. Joints:

   a. Solvent Weld

   b. Threaded

4. Manufacturers: Provide products of one of the following:

   a. Chemtrol as manufactured by Nibco, Inc.

   b. Spears Manufacturing Company

   c. Or approved equal

2.04	MANUFACTURED UNITS	(Not Used)
2.05	EQUIPMENT	(Not Used)
2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)
2.08	MIXES	(Not Used)

2.09 FABRICATION

A. All pipe fabrications for this Work shall be based upon approved shop drawings which, in turn, shall be based upon accurate field verification, by the CONTRACTOR, of all dimensions, elevations, alignments, obstacles, equipment locations, connections and terminations and all other field data critical to the installation of the piping systems.

B. Roll Grooved End Pipe Fabrication:

1. All pipe, couplings, flanges and fittings shall be provided by the grooved end pipe-coupling manufacturer and, insofar as possible, shall be the products of the grooved coupling manufacturer.

2. All pipe ends and fittings shall be cut and roll grooved in the manufacturer's facility.

   a. Pipes shall be accurately cut to the lengths indicated on the approved shop drawings and shall be tagged or stenciled with identifications.

b. All cutting and roll grooving shall be in strict accordance with the manufacturer's specifications.

c. Field cutting, roll grooving or modifications to pipe lengths by the CONTRACTOR shall not be permitted, unless the CONTRACTOR has received prior training, has the correct equipment and tools, and is certified by the grooved end pipe coupling manufacturer to make such modifications.

1) Comply with Section 40 05 05, Exposed Piping Installation.

a) Submittal requirements

b) Field cutting and grooving of pipe

2.10 FINISHES (Not Used)

2.11 SOURCE QUALITY CONTROL

A. Dimensions and Tolerances:

1. Measure dimensions and tolerance in accordance with ASTM D2122.

2. The maximum eccentricity of the inside and outside circumferences of the pipe walls shall be 12%.

B. Sustained Pressure: The pipe shall not fail, balloon, burst, or weep as defined in ASTM D1598.

C. Minimum Burst Pressure: Comply with ASTM D1599.

D. Identification: Mark or label all items with the following information:

1. Intervals: 5 feet maximum

2. Designation:

a. Name of Manufacturer

b. Pipe nominal size

c. Pipe schedule or dimension ratio

d. Plastic material specification

e. Plastic type and grade

f. National Sanitation Foundation seal or mark (potable water piping only)

g. DWV (drain, waste and vent piping only)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Comply with Sections 33 05 00, Buried Piping Installation, and 40 05 05, Exposed Piping Installation.

3.03 PREPARATION (Not Used)

3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. Comply with Section 33 05 00, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.

1. Install expansion joints in all thermoplastic-piping systems, as indicated on the Drawings and as required.

a. Comply with manufacturer's recommendations and procedures for selection, location and installation of expansion joints.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. Comply with Section 33 05 00, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.

3.11 ADJUSTING (Not Used)

3.12 CLEANING

A. Comply with Section 33 05 00, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.

3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not used)

+ + END OF SECTION + +

SECTION 40 05 51

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes labor, materials, equipment, appurtenances, operators and incidentals required for process valves as shown and specified. Work includes all types of valves required for buried, exposed, submerged, and other types of piping except where otherwise specifically included in other Sections.

B. Furnish all labor, materials, equipment and incidentals required to complete the Work.

C. Related Sections:

1. Section 05 05 01, Anchor Bolts, Expansion Anchors and Concrete Inserts

2. Section 09 91 10, Painting

3. Division 26, Electrical

1.02 REFERENCES

A. Reference Standards:

1. ANSI B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250)

2. ASME B16.11, Forged Fittings, Socket-Welding and Threaded

3. ASME B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

4. ASTM A48/A48M, Standard Specification for Gray Iron Castings

5. ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

6. ASTM A159, Standard Specification for Automotive Gray Iron Castings

7. ASTM A216/A 216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

8. ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

9. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

10. ASTM A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

11. ASTM A536, Standard Specification for Ductile Iron Castings

12. ASTM B61, Standard Specification for Steam or Valve Bronze Castings

13. ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings

14. ASTM B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes

15. ASTM B371, Standard Specification for Copper-Zinc-Silicon Alloy Rod

16. ASTM B584, Standard Specification for Copper Alloy Sand Castings for General Applications

17. AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

18. AWWA C500, Metal-Seated Gate Valves for Water Supply Service

19. AWWA C504, Rubber-Seated Butterfly Valves

20. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service

21. AWWA C540, Power-Actuating Devices for Valves and Slide Gates

22. AWWA C550, Protective Epoxy Interior Coatings for Valves and Hydrants

23. AWWA C560, Cast Iron Slide Gates

24. AWWA C800, Underground Service Line Valves and Fittings

25. CMS, “Construction and Materials Specifications” of the of the Ohio Department of Transportation, Latest Edition

26. MSS SP 80 Bronze Gate, Globe, Angle and Check Valves

1.03 DEFINITIONS

A. Repair kit: A set of all fluid sealing and wearing parts used to rebuild a worn, undamaged valve, actuator, or other item to serviceable condition. A repair kit would typically include such items as gaskets, seals, seats, diaphragms, and springs.

1.04 SYSTEM DESCRIPTION

A. The following list provides an index to valves, appurtenances, and valve operators.

Article	Title
2.04.01	Butterfly Valves
2.04.02	Plug Valves
2.04.03	Gate Valves
2.04.04	Check Valves
2.04.05	Ball Valves
2.04.06	Air Release Valves
2.04.07	Air and Vacuum Valves
2.04.08	Pressure Reducing Valves

2.04.09	Globe Valves
2.04.10	Backflow preventer Assemblies
2.04.11	Surge Relief Valves
2.04.12	Flap Valves
2.04.13	Needle Valves
2.04.14	Mud Valves
2.04.15	Angle Valves
2.04.16	Pressure Relief Valves
2.04.17	Hydrostatic Pressure Relief Valves
2.04.18	Automatic Pressure Sustaining Valves
2.04.19	Corporation Stops
2.04.20	Curb Stops
2.04.21	Solenoid Valves
2.04.22	Fire Hydrants
2.04.23	Yard Hydrants
2.04.24	Pinch Valves
2.04.25	Hose Bibbs
2.04.26	Condensate Drain Traps
2.04.27	Strainers
2.04.28	Valve Operators

1.05 SUBMITTALS

A. Shop Drawings: Provide manufacturer's shop drawings, literature, and manuals for all valves, valve appurtenances, and valve operators. For motor operated valves, indicate proposed location of local pushbutton station.

B. Product Data: Submit manufacturer's data on all new or replacement equipment, parts, and valves, including:

1. Dimensions

2. Size

3. Materials of construction

4. Weight

5. Operator weight

6. Calculation for operator torque where applicable

7. Paint and coating information

8. Operator wiring diagrams including:

    a. Power and control circuit ladder logic diagram

    b. Point-to-point wiring diagrams including indication of interfacing signal voltage type and voltage source.

9. Pressure ratings

10. Velocity ratings, as applicable

11. Cv values and headloss curves

12. Control characteristics of modulating valves

13. Certificates of compliance with AWWA Standards, where applicable

14. Corrosion resistance information to confirm suitability of the valve materials for the application. Information on chemical resistance of elastomers shall be furnished from the elastomer manufacturers.

C. Maintenance and Operating Instructions: Distributor-Level documentation applies to this Section.

D. Repair Parts and Maintenance Material: Submit a list of repair parts and maintenance materials for each size and type of valve, operator, or accessory furnished in accordance with paragraph 1.15 of this Section. Include an exploded view or cross-sectional drawing with parts identified or with each list.

E. Quality Assurance/Control Submittals:

1. Field Installation Report:

    a. Furnish manufacturer's service report after inspection of the valves for proper installation with the following:

        1) List of deficiencies in valve installation and recommended corrective action.

2) Statement certifying that valves are properly installed and fully operational except for deficiencies noted.

2. Submit manufacturer's certificates of compliance with ANSI, ASME and AWWA standards listed for product specified in Part 2.

F. Project Record Documents: Provide record documents documenting all deviations, changes, etc. from the originally submitted and approved Shop Drawings.

1.06. QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Supply valves and appurtenances that are standard product in regular production by manufacturers whose products have proven reliable in similar service for at least 2 years.

2. Insofar as possible, valves of the same specific type shall be the product of one manufacturer.

3. Unless otherwise specified, motor operators and air operators shall be installed by the manufacturer of the valve. All shaft couplings and mounting plates shall be coordinated by, approved by, and warranted by the valve manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that work.

2. Materials shall be shipped, delivered, and unloaded in the manufacturer’s original packaging.

B. Storage and Protection:

1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

2. Store all equipment in secure covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:

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

D. Valves which are cracked, dented, or otherwise damaged or dropped will be rejected.

1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	WARRANTY	(Not Used)
1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER’S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)

1.15 MAINTENANCE

A. Repair Parts:

1. For valves 2-inch nominal size and smaller:

a. One (1) repair kit for every 10 or less of each size and type of valve furnished.

2. For valves sizes greater than 2-inch nominal size:

a. One (1) repair kit for every 10 or less of each size and type of valve furnished.

b. One (1) set of bearings, bushings, stems, metallic seats and discs or plugs, and all other wearing parts, for every 20 or less of each size and type.

3. For motor operators, provide:

a. One (1) spare limit switch assembly for every 20 or less of each size and type operator furnished.

4. For pneumatic operators, provide:

a. One (1) repair kit for every 10 or less of each size and type operator furnished.

b. One (1) spare solenoid valve for every 10 or less of each size, type, and voltage furnished.

c. One (1) spare air filter element for every 10 or less of each size and type furnished.

5. For valve external limit switches, provide 1 spare limit switch for every 20 or less of each size and type furnished.

6. For solenoid valve operators, provide 1 spare solenoid assembly for every 10 or less solenoid valves of each voltage, size, and type furnished.

7. For strainers, provide 1 set of gaskets and seals for every 5 or less of each size and type strainer furnished.

8. For strainers, provide 1 spare strainer element for every 20 or less of each size and type strainer furnished.

9. For pressure or float actuated valves, except pressure relief, provide 1 actuator repair kit for every 10 or less of each size and type valve furnished.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. See paragraph 2.04 of this Section.

2.02 EXISTING PRODUCTS (Not Used)
2.03 MATERIALS (Not Used)

2.04 MANUFACTURED UNITS

A. General Requirements:

1. Manufacturer's Name and Working Pressure: Cast information in raised letters on valve body, unless otherwise approved.

2. Type of Ends: Comply with Schedule on Drawings or as specified.

3. Flanged Valve Ends: Comply with ASME B16.1, Class 125 unless otherwise specified.

4. Buried Valves: Provide with adjustable 2-piece valve boxes with extension stems, operating nuts and covers unless otherwise shown or specified.

5. Bolts, Connecting Buried or Submerged Valves:

a. Bolts and Studs: Type 304 stainless steel, unless otherwise shown or specified.

b. Nuts: Type 304 stainless steel, unless otherwise shown or specified.

6. Exposed Bolts and Studs Embedded in Concrete and Studs for Wall Pipe: Type 304 stainless steel, unless otherwise shown or specified.

7. All Other Bolts, Nuts, and Studs: Comply with ASTM A307, Grade B; or ASTM A354.

8. Bolt Heads and Nuts: Hexagon

9. Manually operated valves, with or without extension stems, shall require not more than a 40-pound pull on the manual operator to open or close a valve against the specified criteria. The gear actuator and the valve components shall be able to withstand a minimum pull of 200 pounds on the

manual operator and an input torque of 300 foot-pounds to an actuator nut. Manual operators include handwheel, chain, crank, lever and a T-handle wrench.

10. Provide all valves to turn clockwise to close, unless otherwise specified.

11. Provide all valves with permanent markings for direction to open.

12. All materials of construction of the valves shall be suitable for the application as shown.

13. Protect wetted parts from galvanic corrosion due to contact of 2 different metals.

2.04.01 BUTTERFLY VALVES (Not Used)

2.04.02 PLUG VALVES

A. Type 1 - Eccentric Plug Valves:

1. Manufacturer and Model:

a. DeZurik Corp; PEF

b. Or approved equal

2. Style: Nonlubricated, rectangular port, eccentric plug with resilient plug face.

3. Construction:

a. Body and Plug Material: Cast iron, ASTM A126, Class B.

b. Bearings: Corrosion resistant, permanently lubricated. Provide grease fittings for upper and lower bearings.

c. Seat: Raised seat with 1/8-inch welded overlay of 90% nickel.

d. Bushings: Bronze

e. Plug Facing:

1) Sewage or Stormwater Service - Hycar or Buna-N Seals

2) Gas Service - Viton

f. Packing: Multiple V-ring type, capable of being adjusted or repacked without disassembly of valve. Packing on exposed valves shall be externally adjustable and capable of being repacked without removing the actuator.

g. Lining: Unlined, unless rubber lining specified in the Valve Schedule.

4. Pressure Rating: 150 psi, unless otherwise specified in the Valve Schedule.

5. End Connections: As specified in the Valve Schedule or Drawings.

6. Operator:

a. As specified in the Valve Schedule or Drawings.

b. Furnish weatherproof completely enclosed mounting bracket and actuator cover for buried and submerged valves.

7. Valve packing arrangement shall 2 sets of packing and be suitable for vacuum service.

8. Gear actuators shall be rated for bi-directional shut-off at the valves design pressure rating.

9. Grit seals on both the upper and lower plug shafts.

10. Tested and certified bubble tight at full rated pressure in both directions.

11. 316 Stainless steel assembly nuts and bolts.

12. Paint dry film thickness of 8-10 mils on interior and exterior surfaces.

2.04.03 GATE VALVES (Not Used)

2.04.04 CHECK VALVES

A. Type 1 - Cushioned Swing Check Valves:

1. Manufacturer and Model:

a. APCO model CVS-6000-BMB (Series 6000B)

b. Or approved equal

2. Style: Counterweighted swing check with all attached adjustable oil cushioning chamber. Disc arm shall include a double clevis hinge to assure self-leveling and even load distribution upon closing. Buffer permits free opening, but positive non-slam closure of the disc. The oil hydraulic buffer shall make contact with the disc during the final 10% of closure to control the disc until shut-off in a manner to prevent slam and water hammer. Valves 8" and larger shall have a drain plug located on the bottom of the valve. Air cushion systems are not acceptable.

3. Construction:

a. Body, cover disc, levers: Ductile Iron, ASTM A536

b. Disc Arm: Ductile Iron ASTM A536

c. Shaft: Type 303 stainless steel per ASTM A582

d. Seat: 316 stainless steel per ASTM A276 with an O-ring seal, and locked into place with stainless screws.

e. Seating: Nitrile Butadiene Rubber (NBR)

f. Stuffing box packing: Composition

g. Cushion Chamber Assembly:

1) Buffer Rod: 303 Stainless steel per ASTM A582.
2) Oil Reservoir: 316 stainless steel per ASTM A240.

3) Hydraulic hoses are to be S.A.E. certified

4. Pressure Rating: 150 psi minimum, unless otherwise specified in the Valve Schedule.

B. Type 2 - Bronze Swing Check Valves: (Not Used)

C. Type 3 - Iron Body Swing Check Valves: (Not Used)

D. Type 4 - Iron Body, Ball Check Valves:

1. Manufacturer and Model:

a. Flygt, HDL Flanged, Type 5087 AZ

b. Or approved equal

2. Construction:

a. Body: Cast iron, ASTM A159, Class 35

b. Ball: Hollow steel with vulcanized Nitrile rubber.

3. Pressure Rating: 150 psi minimum, unless otherwise specified in the Valve Schedule.

4. End Connection: Flanged, ASME B16.1, Class 125

E. Type 5 - Process Air System Check Valves: (Not Used)

F. Type 6 - Abrasion Resistant Check Valves:

1. Manufacturer and Model:

a. Linatex, Linavalve FC

b. Or approved equal

2. Style: Rubber lined flex check valve with 2-piece body.

3. Construction:

a. Body: Cast iron

b. Body and Inlet Liner: Natural black rubber, unless otherwise specified in the Valve Schedule.

c. Flapper: Steel plate disc covered with cord reinforced natural black rubber, unless otherwise specified in the Valve Schedule.

4. End Connections: Flanged, ASME B16.5, 125/150 pounds

5. Pressure Rating: 125 psi, minimum

6. Repair Parts: Provide 1 additional flapper for each valve furnished.

G. Type 7 - Plastic Swing Check Valves:

1. Manufacturer:

a. Asahi/America

b. Or approved equal

2. Style: Horizontal swing check

3. Construction:

a. Body and Bonnet: PVC

b. Disc: PVC

c. Seat: EPDM, unless otherwise specified in the Valve Schedule.

d. Seals: EPDM, unless otherwise specified in the Valve Schedule.

4. End Connections: Flanged, ASME B16.1

5. Pressure Rating: 150 psi at 80°F for valves up to 3 inches in size, 100 psi at 80°F for valves 4 inches to 6 inches in size, unless otherwise specified in the Valve Schedule.

H. Type 8 - Plastic Ball Check Valves:

1. Manufacturer:

a. Chemtrol, division of Nibco, Inc.

b. Asahi/America

c. Or approved equal

2. Style: True union, ball check

3. Construction:

a. Body and Ball: Same material as connecting piping, unless otherwise specified in the Valve Schedule.

b. Seat and Seals: EPDM, unless otherwise specified in the Valve Schedule.

4. End Connections: Socket welded, unless otherwise specified in the Valve Schedule.

5. Pressure Rating: 150 psi at 120°F for valves up to 2 inches in size, 100 psi at 120°F for valves 3 inches to 4 inches in size, unless otherwise specified in the Valve Schedule

I. Type 9 - Plastic Y-Check Valves:

1. Manufacturer:

a. Hayward

b. George Fischer

c. Or approved equal

2. Style: Y-Type spring operated check valve, designed to remain closed with no backflow.

3. Construction: PVC with Viton seat and cap seal.

4. End Connection: Socket welded, unless otherwise specified in the Valve Schedule.

J. Type 10 - Ball Check Valves - Size 2 inches and smaller:

1. Manufacturer:

a. Flygt, Model HDL, Type 2002

b. Or approved equal

2. Style: Sinking type ball

3. Construction:

a. Body: Bronze

b. Cap: Bronze, Threaded Cap, Rubber gasket

c. Ball: Sinking type, Hollow stainless steel, Specific Gravity greater than 1.0

4. Connections: Female Threaded

5. Pressure Rating: 150 psi

6. Temperature Rating: 180°F

2.04.05 BALL VALVES

A. Type 1 - 2-Inch and Smaller, 2-Way; Brass Ball Valves:

1. Manufacturer and Model:

a. Jenkins, Fig. 21J

b. Jamesbury, Clincher, Style 21-11

c. Or approved equal

2. Style: Standard ball with circular port

3. Construction:

a. Body: Brass

b. Ball: Brass

c. Stem: Brass or Composition Alloy, ASTM B371 steel

d. Seat: TFE

4. End Connection: Threaded

5. Pressure Rating: 400 psi

6. Operator: Lever, zinc plated steel or Type 316 Stainless Steel construction, unless otherwise specified in the Valve Schedule.

B. Type 2 - 2-Inch and Smaller, 2-Way, Stainless Steel Ball Valves:

1. Manufacturer and Model:

a. Red-White Valve Corp. Figure 4550 and 4880.

b. Velan Valve.

c. Or approved equal.

2. Style: Standard ball with circular port.

3. Construction:

a. Body: Type 316 stainless steel

b. Ball: Type 316 stainless steel

c. Stem: Type 316 stainless steel

d. Seat and Seal: TFE

e. Handle: Stainless steel

4. End Connections: Threaded

5. Pressure Rating: 400 psi, minimum

6. Operator: Lever, unless otherwise specified in the Valve Schedule.

C. Type 3 - 2-Inch and Smaller, 3-Way Ball Valves:

1. Manufacturer and Model:

   a. Flowserve/Worcester, Series 18/19

   b. PBM, Inc., MP Series

   c. Velan Valve

   d. Or approved equal

2. Style: Opposite side inlets, bottom outlet.

3. Operation: 180 degree lever with shut-off at 90 degree position.

4. Construction:

   a. Body: Ductile iron or carbon steel

   b. Ball: Gray iron, ductile iron, or cast steel

   c. Seats: Reinforced TFE

   d. Stem: Type 316 stainless steel

5. End Connections: As specified in the Valve Schedule.

6. Pressure Rating: 400 psi, minimum.

7. Operator: Lever, unless otherwise specified in the Valve Schedule.

D. Type 4 - 3 and 4-Inch, 2-Way, Iron Body Ball Valves.

1. Manufacturer and Model:

   a. Jamesbury, Styles 5150

   b. Velan Valve

   c. Or approved equal

2. Style: Standard ball with circular port

3. Construction:

a. Body: Gray iron, ductile iron, carbon steel or cast steel

b. Ball: Gray iron, ductile iron or cast steel

c. Seals: TFE

d. Seat: Glass-filled TFE

e. Stem: Stainless steel

4. End Connections: Flanged, ASME B16.1, Class 150.

5. Pressure Rating: 200 psi minimum, unless otherwise specified in the Valve Schedule.

6. Operator: Lever, unless otherwise specified in the Valve Schedule.

E. Type 5 - Plastic True Union Ball Valves:

1. Manufacturer and Model:

a. Chemtrol, TU Series Tru-Bloc

b. Georg Fischer, Type 375 or 546

c. Or approved equal

2. Style: Standard ball with circular port

3. Construction:

a. Body: Same material as connecting piping, unless otherwise specified in the Valve Schedule.

b. Ball: Same material as connecting piping, unless otherwise specified in the Valve Schedule.

c. Seals: EPDM, unless otherwise specified in the Valve Schedule.

d. Seats: Teflon

4. End Connections: Socket welded, unless otherwise specified in the Valve Schedule.

5. Pressure Rating: 230 psi at 70°F, 150 psi at 120°F

6. Operator: Lever, unless otherwise specified in the Valve Schedule.

2.04.06 AIR RELEASE VALVES (Not Used)

2.04.07 AIR AND VACUUM VALVES

A. Type 1 - Water Service Air and Vacuum Valves: (Not Used)

B. Type 2 –Sewage Air and Vacuum Valves: (Not Used)

C. Type 3 - Water Service Combination Air Valves: (Not Used)

D. Type 4 - Combination Sewage Air Valves:

1. Manufacturer and Model:

a. Val-Matic Wastewater Combination Air Valves (Dual Body):

1) Val-Matic Model 48A/306 (3/16 inch orifice)

2) Val-Matic Model 49A/308 (7/16 inch orifice)

b. Or approved equal

2. Pipe air release valve to air and vacuum valve with 2-inch diameter piping and 2-inch isolation gate valve.

3. Construction:

a. Body: Cast Iron (ASTM A126)

b. Float: 316 stainless steel

c. Leverage Frame: 316 stainless steel

d. Stem: 316 stainless steel

2.04.08 PRESSURE REDUCING VALVES (Not Used)

A. Type 1 - Single Disc Pressure Reducing Valves:

1. Manufacturer and Model:

a. Fischer Regulators, Series 95

b. Or approved equal

2. Style: Self operated.

3. Construction:

a. Body: Stainless steel

b. Orifice: Type 416 stainless steel

c. Seating Surface: Type 416 stainless steel

d. Diaphragm: Type 302 stainless steel

4. Required Features:

a. Maximum Inlet Pressure: 300 psi

b. Pressure Adjustment: Nut operated

5. Outlet Pressure Range: As specified in the Valve Schedule.

B. Type 2 - Hydraulically Operated Pressure Reducing Valves:

1. Manufacturer and Model:

a. G.A. Industries, Inc., Fig. 4500-D

b. Or approved equal

2. Style: Single seated, pilot controlled, self contained differential piston type.

3. Construction:

a. Body and Cover: Cast iron

b. Piston, Liner, and Pilot Valve: Bronze

c. Seat Crown: Bronze (Valves without V-ports and which throttle across the seat shall have stainless steel seats.).

d. Piston Cup, and Liner Cup: Leather or Buna-N.

e. Seat Washer: Buna-N.

f. Rod, Gland, and Bushing: Brass

g. Follower Rings: Bronze or brass

h. Screws: Stainless steel

i. Control Piping and Auxiliary Valves: Brass

j. Sensing Lines: Copper

k. Gasket: Composition

4. Pilot Valve:

a. Single seated, balanced type, globe body.

b. Diaphragm-operated and spring loaded.

c. Adjustable over a minimum range of 30 psi.

5. Operating Features:

a. Reduce high inlet pressure to a determined low delivery pressure without shock or jar.

b. Air and water cushioned to prevent hammer and shock.

c. Provided with indicator as integral part of the valve to show the position of the piston within the body.

2.04.09 GLOBE VALVES

A. Type 1 - Regrind-Renew Plug Disc Globe Valve.

1. Manufacturer:

a. Jenkins, Fig. 2032J

b. Or approved equal

2. Standard: MSS-SP-80

3. Style: Union bonnet, regrind-renew plug disc, seat disc, and rising stem.

4. Construction:

a. Body and Bonnet: Bronze, ASTM B62

b. Disc: Stainless steel

c. Seat Ring: Stainless steel

d. Packing: As suitable for service required. No asbestos permitted.

e. Handwheel: Commercial aluminum or malleable iron.

5. End Connections: Threaded

6. Pressure Rating: 300 psi

B. Type 2 - Renewable Disc Globe Valve - Sliding Stem.

1. Manufacturer:

a. Jenkins, Fig. 106BJ

b. Or approved equal

2. Style: Renewable composition disc, sliding stem, reverse action.

3. Construction:

a. Body: Bronze, ASTM B62

b. Disc: PTFE

c. Cap Spring: 18-8 stainless steel

d. Packing: Teflon impregnated

e. Stem: Bronze

4. End Connection: Threaded

5. Pressure Rating: 150 psi

2.04.10 BACKFLOW PREVENTER ASSEMBLIES

A. Type 1 - Reduced Pressure Principle Backflow Preventers:

1. Manufacturer and Model:

a. Cla-Val Co., Model RP-4

b. Or approved equal

2. Style: Reduced pressure principle with independent acting toggle lever check valves, approved for use by OEPA.

3. Components:

a. Two (2) independently acting toggle lever check valves.

b. Automatic pressure differential relief valve

c. Two (2) AWWA, O.S. and Y. gate valves for shutoff purposes.

d. Four (4) test cocks

4. Construction:

a. Body and Cover:

1) 2 inch: Bronze, ASTM B61.

2) 2 1/2 inches and larger: Cast iron ASTM A126, interior epoxy coated.

b. Main Valve Trim: Bronze ASTM B61

c. Differential Relief Valve: Bronze, ASTM B61 with Type 316 stainless steel trim.

5. Required Features:

a. Maximum Working Pressure: 150 psig

b. Temperature Range: 35°F to 110°F

c. Hydrostatic Test Pressure: 300 psig

6. End Connections: Flanged, ASME B16.1, Class 125.

7. Maximum Allowable Pressure Loss:

Valve Size (Inches)	Flow Rate (GPM)	Pressure Loss (PSI)
2	160	11.0
2 1/2	225	7.7
3	320	7.7
4	500	10.0
6	1000	8.3
8	1600	6.0
10	2300	6.8

8. Drain Connections: Pipe to nearest floor drain with PVC Schedule Pipe, pipe size twice diameter of the incoming line, providing minimum 6-inch air gap at drain.

2.04.11 SURGE RELIEF VALVES Not Used)

2.04.12 FLAP VALVES

A. Type 1 - Circular Flap Valves:

1. Manufacturer and Model:

a. Rodney Hunt, Series FV-AC

b. Or approved equal

2. Style: Heavy duty, double pivot point hinge arm design.

3. Construction:

a. Cover and Frame: Cast iron, ASTM A126, Class B

b. Seat: Neoprene, unless otherwise specified in the Valve Schedule.

c. Hinge Pins: Silicon bronze, ASTM B98 or Type 304 stainless steel.

d. Hinge Arms: Bronze, ASTM B584

4. Required Features:

a. Adjustable lower pivot to control amount of cover rotation to assume cover seat and frame seat lie in the same plane.

b. Threaded upper hinge post to adjust valve sensitivity.

c. Lubrication fitting for pivot points.

5. End Connection: Flange, ASME B16.1, Class 150

B. Type 2 - Rectangular Flap Valves:

1. Manufacturer and Model:

a. Rodney Hunt, Series FV-AR

b. Or approved equal

2. Style: Heavy duty, double pivot point hinge arm design.

3. Construction:

a. Cover and Frame: Cast iron, ASTM A126, Class B

b. Seat: Neoprene, unless otherwise specified in the Valve Schedule.

c. Hinge Pins: Silicon bronze, ASTM B98 or Type 304 stainless steel.

d. Hinge Arms: Bronze, ASTM B584.

4. Required Features:

a. Adjustable lower pivot to control amount of cover rotation to assure cover seat and frame seat lie in the same plane.

b. Threaded upper hinge post to adjust valve sensitivity.

c. Lubrication fitting for pivot points.

5. End Connections: Flange, drilled for mounting on wall thimble, unless otherwise specified in the Valve Schedule.

2.04.13	NEEDLE VALVES	(Not Used)
2.04.14	MUD VALVES	(Not Used)
2.04.15	ANGLE VALVES	(Not Used)
2.04.16	PRESSURE RELIEF VALVES	(Not Used)
2.04.17	HYDROSTATIC PRESSURE RELIEF VALVES	(Not Used)
2.04.18	AUTOMATIC PRESSURE SUSTAINING VALVES	(Not Used)

2.04.19 CORPORATION STOPS

A. Type 1:

1. Manufacturer and Model:

a. Mueller Co., Model H-15025 and "Oriseal"

b. Ford Meter Box Co., Model FB600

c. Or approved equal

2. Standard: AWWA C800.

3. Material: Brass or Bronze.

4. End Connections:

a. Inlet: AWWA Thread

b. Outlet: Flared Copper

B. Type 2:

1. Manufacturer and Model:

a. Mueller Co., Model H-10046

b. Ford Meter Box Co., Model FB1600

c. Or approved equal

2. Standard: AWWA C800

3. Material: Bronze or Brass

4. End Connections:

a. Inlet: AWWA Thread

b. Outlet: Female Iron Pipe Thread

2.04.20 CURB STOPS

A. Type 1:

1. Manufacturer and Model:

a. Mueller Co., Model Mark II Oriseal H-15204

b. Or approved equal

2. Standard: AWWA C800

3. Material: Bronze or Brass

4. End Connection:

a. Inlet: Flared Copper

b. Outlet: Flared Copper

B. Type 2:

1. Manufacturer and Model:

a. Mueller Co., Model Mark II Oriseal H-10283

b. Or approved equal

2. Standard: AWWA C800

3. Material: Bronze or Brass

4. End Connections:

a. Inlet: Female Iron Pipe Thread

b. Outlet: Female Iron Pipe Thread

2.04.21 SOLENOID VALVES (Not Used)
2.04.22 FIRE HYDRANTS (Not Used)
2.04.23 YARD HYDRANTS (Not Used)
2.04.24 PINCH VALVES (Not Used)

2.04.25 HOSE BIBBS

A. Type 1 - Exterior:

1. Manufacturer:

a. Jay R. Smith Manufacturing Co., Fig. No. 5509-E

b. Zurn Industries, Fig. No. Z-1300

c. Or approved equal

2. Style: Anti-siphon, non-freeze

3. Construction:

a. Casing: Bronze

b. Box: Bronze

c. Face: Chrome plated with satin refinish

4. Connection:

a. Inlet: 3/4-inch IPS

b. Outlet: 3/4-inch hose thread, universal type.

B. Type 2 - Interior:

1. Manufacture:

a. Crane, No. 17TF

b. Or approved equal

2. Standard: Federal Spec WW-V-51F, Class B for material and design requirements

3. Style: Union bonnet, angle valve

4. Construction:

a. Body and Bonnet: Bronze, ASTM B62 Alloy 836

b. Disc Holder: Bronze

c. Disc: PTFE

d. Packing: Non-asbestos composition

5. Connection:

a. Inlet: 3/4-inch female threaded

b. Outlet: 3/4-inch female threaded. Provide adapter for hose thread 3/4 inch. Also provide quick connect adapter with cap and chain.

6. Pressure Rating: 300 psi non-shock cold water

2.04.26 CONDENSATE DRAIN TRAPS

A. Type 1 - Compressed Air Service, Automatic Drain Trap:

1. Manufacturer and Model:

a. Hankinson International, Model 506 Trip-L-Trap

b. Or approved equal

2. Style: Mechanical actuated automatic trap

3. Features:

a. Float operated pilot type operation

b. Capacity:

1) Maximum: 24 gph

2) Discharge per operation: 0.4 pints

4. Construction:

a. Body: Carbon steel

b. Seal: Viton

c. Internal Mechanical Parts: Corrosion resistant construction.

5. Connections:

a. Inlet: 3/4-inch NPTF

b. Drain: 1/4-inch NPTF

6. Pressure Rating: 300 psi, unless otherwise specified in the Valve Schedule.

2.04.27 STRAINERS

A. Type 1 - Bronze Body Y-Pattern Strainer:

1. Manufacturer and Model:

    a. Mueller Steam Specialties, Model No. 352 or 352M

    b. Or approved equal

2. Style: Y-Pattern with removable strainer screen.

3. Construction:

    a. Body: Cast bronze

    b. Screen: 20 mesh Type 316 stainless steel, unless otherwise specified in the Valve Schedule.

4. Pressure Rating: 400 psi water service at 150°F

5. End Connections: Threaded

6. Required Features:

    a. Blowoff plug: NPT Connection.

B. Type 2 - Iron Body Y-Pattern Strainer:

1. Manufacturer and Model:

    a. Mueller Steam Specialties, Model No. 758

    b. Or approved equal

2. Style: Y-Pattern with removable strainer screen.

3. Construction:

    a. Body and Cover: Cast iron, ASTM A126, Class B

    b. Screen: Type 316 stainless steel sheet, 1/16-inch perforations for line sizes 4 inches in diameter and less and 1/8-inch perforations for line sizes greater than 4 inches in diameter, unless otherwise specified in the Valve Schedule.

4. Pressure Rating: 150 psi water service at 150°F

5. End Connection: Flange, ASME B16.1, Class 125

6. Required Feature:

a. Cover flange tapped for blowoff plug.

b. Blowoff plug

2.04.28 VALVE OPERATORS

A. Manual Operators:

1. Type: Handwheel, handlever, chainwheel, chainlever, or operating nut.

2. Operation:

a. Turn counter-clockwise to open, unless otherwise specified in the Valve Schedule.

b. Indicate direction of operation on the valve.

3. Location:

a. Provide manual operators in accordance with the general requirements below, unless otherwise specified in the Valve Schedule.

1) Handwheel or Lever: For valves operable from floor level.

2) Chainwheel or Chainlever: For valves more than 6 feet-6 inches above the operating floor level.

3) 2 inch square Operating Nut: For buried valves

4. Gearing:

a. Location:

1) All valves requiring operating torque in excess of that provided by maximum pull of 80 pounds

on handwheel or chainwheel or maximum input of 150 foot-pounds on operating nuts or as scheduled.

2) All butterfly, ball and plug valves which call for handwheel or chainwheel operators.

b. Design: Totally enclosed.

5. Chainwheel Operator Details:

a. Chainwheel: Manufacturer's standard design or sprocket wheel bolted directly to valve handwheel.

b. Chain Length and Sizes: To suit each application and permit operation at a height of 4 feet above floor level.

c. Chain Hold Device: Equip each operator with 1/2-inch hook bolt located to hold chain from walking area. Hook and anchor to be Type 316 stainless steel.

d. Chain to be coil proof Type 316 stainless steel.

6. Additional Butterfly Valve Operator Details:

a. Standard: Comply with all applicable portions of AWWA C504, latest edition.

b. Handlever operators shall be provided with a spring-loaded notch plate positioning handle. All parts of the handlever assembly, including notch plate shall be 300 series stainless steel.

7. Permanently attached handlever to valve. One (1) portable lever for a number of valves shall not be acceptable.

B. Motor Operators:

1. Type 1 - Electric Open/Close Actuator:

a. Manufacturer:

1) Beck, Group 11, 14, or 31

b. General:

1) Self contained unit with drive motor and controls, reduction gearing, limit the torque switch gearing, declutching device and auxiliary handwheel.

2) Conform to the requirements of AWWA C504 and AWWA C540 as modified herein.

3) Torque Rating: 2.0 times the maximum required torque suggested by the manufacturer based on valve size, shaft size, bearing friction, type of disc and valve shut-off pressure, velocity, type of disc and valve operation in 32° F temperature water.

4) Gearing capable of opening or closing valve from one extreme to the other in not less than 30 seconds nor more than 180 seconds.

5) Four (4) adjustable cam operated SPDT limit switches rated at least 5 A, 125 VAC "L" (lamp load) for Group 11 and 14 actuators.

6) Auxiliary Limit Switches for Remote Position Indication: 4 SPDT required; 2 for open and 2 for closed indication.

7) Enclosure: NEMA 4X.

8) Provide readily accessible local 5-position Auto-Stop-Forward-Stop-Reverse switch to open or close the actuator.

9) Auxiliary contact for monitoring the position of the 5-position local control switch is in AUTO indicating remote control is enables at the actuator.

c. Electrical Features:

1) Coordinate interfacing of the motor operators as shown on the Drawings.

2) Electrical Characteristics:

a) Power Supply: 120 V, single phase, 60 Hz.

b) Control Power: 120 V, single phase, 60 Hz.

3) Duty Cycle: 100 starts per hour.

4) 115 V space heater on control enclosure to maintain control devices at least 5°C above ambient. Connect space heater to control circuitry.

5) Local Controls:

a. Refer to the Instrumentation Drawings and the Electrical Drawings for specific control and electrical requirements for each motor operated valve. Provide the control components shown.

b. Mount control components on the cover of the unit or on a wall mounted local control panel as shown on the Drawings.

2. Type 2 - Electric Open/Close Actuator:

a. Manufacturer:

1) Limitorque MXA

b. General:

1) Standard: Comply with AWWA C540.

2) Furnish electric motor operators as specified.

3) Provide self contained unit consisting of motor, operator unit gearing, limit switch gearing, limit switches, torque switches, stem nut or bored and key-wayed drive sleeve, declutch lever,

auxiliary hand-wheel, reversing controller, local start/ stop pushbutton station with indicating lights as shown, local/remote selection lockout stop unit, space heaters and control power transformers, fully assembled, wired and ready for field connections.

4) Size operator for an operating head of at least twice that specified.

5) Type:

a) The operator shall be the open or close type (O/C) or modulating type (MOD) as specified. Modulating-type operators shall be designed to hold the slide gate plate in the intermediate position between fully open and fully closed without creeping or fluttering.

b) The operator shall be suitable for use on a nominal 460 V, 3-phase, 60 Hz power supply and is to incorporate integral reversing starter, local control facilities, and terminals for remote control and indication connections.

c) The operator shall include a device to ensure that the motor runs with the correct rotation for the required direction of gate travel with either phase sequence of the 3-phase power supply connected to the actuator.

d) It shall be possible to carry out the setting of the torque, turns, and configurations of the indication contacts without the necessity to remove any electrical compartment covers. Use of Bluetooth communications is not acceptable.

e) The operator shall be capable of functioning in an ambient temperature ranging from minus 10ºF to +120ºF.

6) Operator Sizing: The operator shall be sized to guarantee gate closure at the specified seating and unseating heads. The safety margin of motor power available for seating and unseating the slide gate shall be sufficient to ensure torque switch trip at maximum torque with the supply voltage 10% below nominal. The operating speed shall be such as to provide gate closing and opening at approximately 10 to 12 inches per minute unless otherwise stated in the specifications.

7) Motor:

a) The electric motor shall be Class F insulation for 15 minutes at 104ºF or twice the slide gate stroking time, whichever is the longer, at an average load of at least 33% of maximum slide gate torque. The motor shall be a suitable rated 4-poled motor.

b) Electrical and mechanical disconnection of the motor shall be possible without draining the lubricant from the operator gearcase. Plugs and sockets are not acceptable as a means of electrical connection for the motor.

c) Protection shall be provided for the motor as follows:

(1) The motor shall be de-energized in the event of stall when attempting to unseat a jammed slide gate.

(2) Motor temperature shall be sensed by a thermostat to protect against overheating.

(3) Single phasing protection.

8) Gearing:

a) The operator gearing shall be totally enclosed in an oil-filled gear case suitable for operation at any angle. All main drive gearing shall be of metal construction. For modulating applications, the hammer-blow backlash shall be omitted from the output gear train. The output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the operator, and the design shall permit the gear case to be opened for inspection or disassembled without releasing the stem thrust or taking the slide gate out of service.

b) A synthetic gear oil such as Mobile SHC632 or approved equal shall be used to lubricate the gear case. Special or exotic lubricants shall not be used.

9) Hand Operation:

a) A handwheel shall be provided for emergency operation that is engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The hand/auto selection lever shall be padlockable in both "Hand" and "Auto" positions. It shall be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.

b) The handwheel drive shall be mechanically independent of the motor drive, and any gearing shall permit emergency manual operation in a reasonable time.

10) Drive Bushing: The operator shall be furnished with a drive bushing easily detachable for machining to suit the slide gate stem or gearbox input shaft. The drive bushing shall be positioned in a detachable base of the operator. Thrust bearings, when housed in a separate thrust base, shall be of the sealed-for-life type.

11) Torque and Turns and Positional Accuracy:

a) Torque and turns limitation to be adjustable as follows:

b) Position Setting Range. 0.5 to 100,000 turns, with resolution to 15 degrees of operator output.

c) Torque Setting. 40% to 100% rated torque.

d) Position sensing shall be accomplished with absolute encoders.

e) Torque sensing shall be effected purely electrically or electronically.

f) "Latching" to be provided for the torque sensing system to inhibit torque off during unseating or during mid-travel against high inertia loads.

g) Overall accuracy (actuator mechanical output/demand) shall be 1/2%.

h) The electric circuit diagram of the operator shall not vary regardless of whether the slide gate is to open or close on torque or position limit. A setting tool shall be used for nonintrusive calibration and interrogation of the operator.

12) Remote Slide Gate Position/Operator Status Indication:

a) The operator shall provide a local display of the position of the slide gate, even when the power supply is not present.

b) In the event of a (main) power (supply) loss or failure, the position contacts shall continue to supply remote position feedback and maintain interlock capabilities.

c) A back-up power source shall be provided in the operator to ensure maintained local and remote indication should the operator be operated manually when the power supply is interrupted.

d) The position of the operator and slide gate must be updated contemporaneously, even when the power supply is not present.

e) Four contacts shall be provided which can be selected to indicate any position of the slide gate with each contact selectable as normally open or normally closed. The contacts shall be rated at 0.5 A, 120 VAC.

f) As an alternative to providing valve position, any of the four above contacts shall be selectable to signal one of the following:

(1) Gate opening or closing

(2) Gate moving (continuous or pulsing)

(3) Motor tripped on torque in mid-travel

(4) Motor stalled

(5) Actuator being operated by handwheel

13) Local Position Indication:

a) The operator shall include a digital position indicator with a display from fully open to fully closed in 1% increments. Red, green, and yellow lights corresponding to open, closed, and intermediate positions, respectively, shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

b) The local display shall be large enough to be viewed from a distance of 6 feet when the actuator is powered up.

c) Provide a contactless transmitter to give a 4-20 mA analog signal corresponding to gate travel for remote indication.

14) Integral Starter and Transformer:

a) The reversing starter, control transformer, and local controls shall be integral with the slide gate operator, suitably housed to prevent breathing and condensation buildup. For ON/OFF service, this starter shall be electromechanical type suitable for 60 starts per hour and of rating appropriate to motor size. For modulating duty, the starter shall be solid state and suitable for up to a maximum of 1,200 starts per hour. The modulating service operator shall also include dynamic braking. The controls supply transformer shall be from two of the incoming three phases. It shall have the necessary tappings and be adequately rated to power for the following functions:

1) 120 VAC energization of the contactor coils.

(2) Either 120 VAC output for discrete control or 24 VDC for modulating control as depicted on the Contract Drawings.

(3) Supply for all the internal electrical circuits.

b) The primary and secondary windings shall be protected by easily replaceable fuses.

15) Integral Push Buttons and Selector:

a) Local controls for Open, Close, and Stop shall be integral to the operator and a local/remote selector switch shall be padlockable in any one of the following three positions:

(1) Local control only

(2) Off (no electrical operation)

(3) Remote control plus local stop only

b) It shall be possible to select maintained or non-maintained local control.

c) The local controls shall be arranged so that the direction of slide gate travel can be reversed without the necessity of stopping the actuator.

16) Control Facilities:

a) The necessary wiring and terminals shall be provided in the operator for the following control functions:

(1) Removable links for substitution by external interlocks to inhibit slide gate opening and/or closing.

(2) Connections for external remote controls fed from an internal supply of 120 VAC for the following methods of control:

(a) Open, close, and stop

(b) Open and close

(c) Overriding emergency, shutdown to close (or open) slide gate from a "make" contact.

(d) 2-wire control, energize to close (or open), de-energize to open (or close).

(3) Selection of maintained or push-to-run control for modes (1) and (2) above shall be provided and it shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of approximately 300 milliseconds.

(4) The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2 kV.

17) Monitoring and Diagnostics Facilities:

a) Facilities shall be provided for monitoring operator operation and availability as follows:

(1) Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer only when the local/off/remote selector is in the "remote" position to indicate that the actuator is available for remote operation.

(2) It shall be possible to provide indication of thermostat trip and "remote" selected as discreet signals.

(3) A non-intrusive hand-held setting instrument, capable of duplex communications for uploading and downloading all variables for the operator as well as performing detailed diagnostics shall be provided. Setting instrument shall be capable of extracting operator configuration and historical files from operator to onboard memory storage for uploading into PC-based software. Use of Bluetooth communications are acceptable.

(4) Operators shall include a diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator or valve performance. Facilities for a non-intrusive Windows-based software package, capable of duplex IrDA communications shall be provided to allow actuator configuration and diagnostic information to be

reviewed, analyzed and reconfigured. Additionally, diagnostic data shall be available over an IrDA™ port.

(5) Provision shall be made to locally display slide gate torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate slide gate troubleshooting and diagnostics.

(6) Diagnostic status screens shall be provided to show multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently. All diagnostic information shall be contained on no more than 4 screens so multiple functions can be checked simultaneously.

18) Wiring and Terminals:

a) Internal wiring shall be of tropical grade polyvinyl chloride (PVC) insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.

b) The terminals shall be embedded in a terminal block of high tracking resistance compound.

c) The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal.

d) The terminal compartment of the operator shall be provided with a minimum of 3 threaded cable entries.

e) All wiring supplied as part of the operator shall be contained within the main enclosure for physical and environmental protection. External conduit connection between components is not acceptable.

f) Control logic circuit boards and relay boards must be mounted on plastic mounts to comply with double insulated standards. No more than a single primary size fuse shall be provided to minimize the need to remove single covers for replacement.

g) A durable terminal identification card showing plan of terminals shall be provided attached to the inside of terminal box cover indicating:

(1) Serial number

(2) External voltage values

(3) Wiring diagram number

(4) Terminal layout

h) This shall be suitable for the CONTRACTOR to inscribe cable core identification beside terminal numbers. This work, inscribing cable core identification, shall be completed under Division 16, Electrical.

19) Modulating Requirements: Modulating operators shall include a proportional position servo amplifier. The proportional position servo amplifier shall be designed to accept a 4-20-mA direct current (mADC) input signal. The unit shall contain the following control functions.

a) Span: Using the non-intrusive setting instrument, this function shall calibrate

the position feedback potentiometer to cause full rotation of the output shaft to correspond to the full 0 to 100% range of the signal from the set point controller.

b) Zero: Using the non-intrusive setting instrument, this function shall calibrate the position feedback potentiometer to cause the travel of the output shaft to be properly centered.

c) Dead Band: Using the non-intrusive setting instrument, this function shall control the magnitude of error signal that occurs before the motor begins to rotate to prevent hunting. Feedback potentiometers will not be permitted. Modulating-type electrically operated slide gates shall include gate position transmitter. The output signal from the gate position transmitter shall be 4-20 mADC. The gate control shall be provided with selector switches to allow local open/close operation or automatic modulating control from the remote 4-20 mADC signal. The selector switches shall be provided on the limit switch compartment.

20) Enclosure:

a) Operator shall be "O" ring sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof "O" ring seal between the terminal compartment and the internal electrical elements of the operator fully protecting the motor and all other internal electrical elements of the operator from moisture and dust when the terminal cover is removed on site for cabling.

b) Enclosure must allow for temporary site storage without the need for electrical supply connection.

c) All external fasteners shall be Type 316 stainless steel.

d) Operator for explosion/hazardous applications shall in addition be certified flameproof for Zones 1 and 2 (Divisions 1 and 2) Group gases.

21) Start-Up Kit: Each operator shall be supplied with a start-up kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

3. Type 3 - Electric Analog Modulating Control Type:

a. Manufacturer:

1) Beck: Group 11, 14, or 31

b. General Requirements Unless Otherwise Specified:

1) Rotation (as applicable): 100 degrees minimum, reversible.

2) Torque Rating: Catalog published output stall torque of actuator shall be minimum of 2.0 times the catalog published valve breakaway torque (or greatest torque required by valve at any point in the travel) under maximum operating differential pressure conditions.

3) Cycle Time: 20 to 40 seconds for 100 degree turn, unless otherwise specified in the Valve Schedule.

4) Handwheel: Integral manual handwheel shall be provided. Handwheel shall be non-rotating during motorized operation and shall not require the use of a declutch mechanism.

5) Mechanical Stops: Factory adjustable, for preventing both opening and closing overtravel.

6) Gear Rating: Minimum of 2.0 times the actuator stall torque rating.

7) Four (4) adjustable cam operated SPDT limit switches rated at least 5 A, 125 VAC "L" (lamp load) for Group 11 and 14 actuators.

8) Actuators to include a space heater to prevent condensation where applicable.

9) Unrestricted mounting position with no grease fittings or oil fill holes.

10) Provide readily accessible local 5-position Auto-Stop-Forward-Stop-Reverse switches close to or on the actuators.

11) Completely factory wired with terminal block for electrical field connections.

12) Mounting brackets and connecting linkage as recommended by actuator manufacturer.

13) Visual valve position indicator

14) Self-locking gearing

15) Auxiliary contact for monitoring the position of the 5-position local control switch is in AUTO indicating remote control is enabled at the actuator.

c. Motors:

1) Type: Permanent split capacitor reversible with ball bearings and thermal overload protection.

2) Duty: Minimum of 100% duty cycle.

3) Power Supply: 120 V, single phase, 60 Hz, requiring not more than 3.0 A at locked rotor.

d. Enclosures:

1) Totally enclosed cast aluminum.

2) NEMA 4X rating (actuator, motor, and switches).

e. Control:

1) Equip actuator with integral electronics to accept a remote input 4 to 20 mA DC control signal and to position the valve proportionally.

2) Electronics to include zero and span adjustments.

3) Provide actuator with field set choice of valve positions on loss of signal.

4) Provide electronic position feedback device which provides 4 to 20 mA output signal.

f. Actuator Mounting: Ship valves to the actuator manufacturer to mount the actuator on the valves and adjust the limit switches.

C. Air Operators:

1. Type 1 - Dual Acting Open/Closed Air Cylinder Operators:

a. Manufacturer:

1) Henry Pratt Company

2) Or approved equal

b. General Requirements:

1) Cylinder shall be rated at 120 psi.

2) Suitable for pneumatic operation at air pressure range of 80 psi to 100 psig.

3) Capable of moving valve from full open to full closed with the air applied to the cylinder in not less than 30 seconds nor more than 60 seconds.

4) Conforms to AWWA C540.

5) Valve shall fail closed upon loss of air pressure, unless otherwise specified in the Valve Schedule.

c. Construction:

1) Corrosion resistant cylinder

2) Chromium plated stainless steel cylinder rods

3) Rod seals shall be non-adjustable, wear compensating type.

4) Internal and external wiper

d. Accessories:

1) Air Filter: 50 micron, dry type.

2) Limit Switches: Full open, full closed of the number specified in the Valve Schedule.

3) Speed control valve

4) Four-way, 2-position single solenoid valve, with heavy brass or bronze body, NEMA 4X, 120 VAC, 1 phase, 60 hertz with manual operator, unless otherwise specified in the Valve Schedule.

2. Type 2 - Pneumatic Rotary Actuator:

a. Manufacturer and Model:

1) Keystone, Fig. 79U

2) Or approved equal

b. General Requirements:

1) Rack and pinion design, providing constant output torque.

2) Totally enclosed design with no external moving parts.

3) Integral porting to eliminate external tubing.

4) Mechanical position indication readable from a distance of 25 feet by use of contrasting colors.

5) Standard operation of 0 to 90 degrees reversible operation for air.

6) Capable of mounting either in line or transverse to the pipeline and in any valve mounting altitude.

7) Capable of mounting directly to valve top plate without use of special brackets, linkage, or couplings.

8) Factory lubricated and tested for proper operation.

9) Design actuator to allow future addition of spring return feature capable of providing "fail-open" or "fail-closed" operation.

10) Suitable for pneumatic operation at an air pressure range of 80 to 120 psig.

11) Suitable for operation in a temperature range of -20°F to 200°F.

12) Actuator design tested for a minimum of 100,000 cycles under full load with no appreciable wear of parts.

13) Travel stops consisting of a mounting plate with stop cam fitted between the base of the

actuator and the valve mounting flange, externally adjustable through full 90 degrees of valve travel.

c. Construction:

1) Actuator body, and caps, and spring cartridge housing: Precision extruded, hard anodized aluminum.

2) Pistons and pinion: Hardened and tempered alloy steel.

3) Piston seals and O-Rings: Nitrile rubber

4) Bushings: Acetal plastic

d. Accessories:

1) Integral filter/regular, lubricator with gage:

a) Size: 1/2 inch

b) Material: Aluminum body

c) Integral wall mounting: 4 feet above finished floor with stainless steel anchors.

2) Limit switches: Full open, full closed of the number specified with the Valve Schedule.

3) Speed Control Valve

4) 4-Way 2-position single solenoid valve with heavy brass or bronze body, NEMA 4, 120 VAC, 1 phase, 60 hertz with manual operator, unless otherwise specified by the Valve Schedule.

D. Valve External Limit Switches:

1. Provide where shown on the drawings or where scheduled.

2. Refer to Division 16, Electrical, for material requirements of Primary Sensors and Field Instruments.

2.05 EQUIPMENT (Not Used)
2.06 COMPONENTS (Not Used)

2.07 ACCESSORIES

A. General:

1. For valves located less than 5 feet above the operating floor, provide levers on quarter-turn valves less than 6-inch and handwheels on all other valves, unless otherwise shown or specified.

2. For valves located at 5 feet or more above the operating floor, provide chain operators.

3. Where indicated, provide extension stems and floorstands.

B. Handwheels:

1. Conform to the applicable AWWA Standards.

2. Material of Construction: Ductile iron or cast aluminum

3. Arrow indicating direction of opening and word “OPEN” shall be cast on the trim of the handwheel.

4. Maximum Handwheel Diameter: 30 inches

C. Chain Operators:

1. For valves more than 6 feet-6 inches above the operating floor provide chain operators.

2. Chains shall extend to 4 feet above the operating floor.

3. A 1/2-inch stainless steel hook bolt shall be provided to keep the chain out of the walking area.

4. Materials of Construction:

a. Chain: Type 316 stainless steel

b. Chain wheel: Recessed groove type made out of Type 316 stainless steel.

c. Guards and Guides: Type 316 stainless steel

5. Chain Construction:

a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends shall not be acceptable.

6. Provide geared operators where required to position chain wheels in vertical position.

D. Crank Operator:

1. Crank operator shall be removable and fitted with a rotating handle.

2. Maximum Radius of Crank: 15 inches

3. Materials:

a. Crank: Cast-iron or ductile iron

b. Handle: Type 304 stainless steel

c. Hardware: Type 304 stainless steel

E. Extension Stems and Floorstands for Gate Valves:

1. Conform to the applicable requirements of AWWA C560 for sizing of the complete lifting mechanism.

2. Bench and Pedestal Floorstands:

a. For valves requiring extension stems, provide bench or pedestal floorstands with handwheel or crank as indicated. Make provisions for use of portable electric actuator for opening and closing of the valves.

b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with

positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering the housing. A lubrication fitting shall be provided for grease. The base shall be machined.

c. Materials of Construction:

1) Housing: Cast-iron, ASTM A126, Class B

2) Lift Nut: Cast-bronze, ASTM B 98/B 98M

3) Grease Fitting: Stainless steel

4) All Bolting: Type 316 stainless steel

3. Wall brackets for floorstands shall be of Type 316L stainless steel construction.

4. Extension Stems:

a. Materials of Stems and Stem Couplings: Type 316 stainless steel

b. Maximum Slenderness Ratio (L/R): 100

c. Minimum Diameter: 1 1/2 inches

d. Threads: ACME

e. Stem couplings shall be provided where stems are furnished in more than one piece. The couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.

f. A Type 316 stainless steel cap suitable for the square end of the valve stem shall be welded to the bottom of the extension stem.

5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.

6. Stem Guides:

a. Material: Type 316 cast stainless steel with bronze bushing for stem.

b. Maximum stem length between guides: 7 feet.

c. Stem guides shall be adjustable in 2 directions.

7. Furnish stem cover of clear butyrate plastic or grade 153 Lexan with a cast adaptor for mounting cover to bench and floor stands. Furnish stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within the cover. Provide stem cover with mylar tape with legible markings showing the gate position at 1-inch intervals and open and close limits of the gates.

F. Floor Boxes: Provide cast-iron floor boxes for all valves which are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

G. Wrench Nuts:

1. Provide wrench nuts on all buried valves of nominal 2 inches in size, conforming to AWWA C500.

2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN".

3. Material: Ductile iron

4. The nut shall be secured to the stem by mechanical means.

H. Extension Stems for Non-Rising Stem Gate Valves and Quarter Turn Buried Valves:

1. Provide extension stems to bring the operating nut to 6 inches below the valve box cover.

2. Minimum Size and Material: Same as valve stem.

3. Maximum Unsupported Length: 3 feet

4. Provide top nut and bottom coupling of ductile iron with pins and set screws of Type 316 stainless steel.

I. Valve Boxes:

1. Valve boxes shall be as indicated and as required.

2. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose operating nut and stuffing box and rest on bonnet.

3. Material: Cast-iron or ductile iron

4. Coating: 2 coats of asphalt varnish conforming to Federal Specifications.

5. Provide locking lids (where specifically specified or shown) with pick holes with appropriate raised or recessed cast lettering for type of service.

2.08 MIXES (Not Used)
2.09 FABRICATION (Not Used)

2.10 FINISHES

A. Shop Painting and Coatings:

1. Shop prime all ferrous surfaces, excluding machined surfaces in compliance with Section 09 91 10, Painting, using painting system selected.

2. Cover machined iron surfaces including drilled and tapped holes with a heavy coat of protective grease.

3. Shop-finish motor operators.

2.11 SOURCE QUALITY CONTROL (Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)
3.02 EXAMINATION (Not Used)
3.03 PREPARATION (Not Used)

3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. Valves and Appurtenances: Install in accordance with manufacturer's recommendations.

B. Corporation Stops: Install at all points shown and where required to relieve air binding.

C. Location: Install valves for convenient operation of handwheels or wrenches from the operating floor without interfering with access.

D. Orientation of Valves:

1. Install valves plumb and level, unless otherwise shown on the Drawings.

2. Install valves free from distortion and strain caused by misaligned piping, equipment, or other causes.

E. Valve Boxes:

1. Install plumb with the bodies centered directly over the valves.

2. Carefully tamp earth fill around each box to a distance of 4 feet on all sides.

3. Tamp earth fill to the undisturbed trench face, if less than 4 feet.

4. In landscaped and turf areas, provide a concrete pad around each valve box cover. Pad must extend at least 6 inches beyond the cover in all directions and shall be 4 inches minimum in depth. Pad shall be flush with the valve box cover and sloped to drain away from the cover. Concrete work shall comply with Section 600 of the CMS.

F. Hydrants and Connecting Pipe: Install in accordance with detail shown on the Drawing.

G. Painting: Paint and color code all exposed valves and accessories including valve box covers in accordance with Section 09 91 10, Painting.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. General: Adjust all parts and components as required to provide correct operation.

B. For Fire Hydrants: Prior to backfill, obtain inspection by Fire Department, as required.

C. Manufacturer's Field Service: Retain qualified factory-trained servicemen of the manufacturer to check and adjust the installation of butterfly valves, pressure reducing valves and surge relief valves, motor operated valves, air operated valves, and other valves specified in the Valve Schedule. Minimum time period required for checkouts is 8 hours for each type of valve, if not otherwise specified. All costs, including travel, lodging, meals and incidentals, for visits shall be at no additional cost to the OWNER.

D. Field Testing:

1. Conduct functional field test of each valve in presence of the CMT.

2. Demonstrate that each part and all components function together correctly.

3. Provide all testing equipment.

E. Demonstrate satisfactory opening and closing of valves at the specified criteria requiring not more than 40 pounds effort on the manual actuators.

F. Test 10% of each type of valve by applying 200 pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

3.11	ADJUSTING	(Not Used)
3.12	CLEANING	(Not Used)
3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULE	(Not Used)

+ + END OF SECTION + +

SECTION 40 05 75

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes testing required to demonstrate the piping system's compliance with contract documents and all applicable codes. Tests include water, air, and smoke tests as specified herein.

B. Furnish all labor, material, equipment and incidentals as required.

C. Related Sections:

1. Section 33 05 00, Buried Piping Installation

2. Section 40 05 05, Exposed Piping Installation

1.02 REFERENCES (Not Used)
1.03 DEFINITIONS (Not Used)
1.04 SYSTEM DESCRIPTION (Not Used)

1.05 SUBMITTALS

A. Product Data: Submit new or replacement equipment and parts data.

B. Quality Assurance/Control Submittals:

1. Test Reports: Provide the following:

a. Written description of proposed testing methods, procedures, and apparatus to the Owner’s Representative at least 48 hours in advance of testing.

b. Test report for each test to the Owner's Representative certifying the test pressure, duration of the test, and system performance.

1.06	QUALITY ASSURANCE	(Not Used)
1.07	DELIVERY, STORAGE AND HANDLING	(Not Used)
1.08	PROJECT/SITE CONDITIONS	(Not Used)
1.09	SEQUENCING	(Not Used)
1.10	SCHEDULING	(Not Used)
1.11	WARRANTY	(Not Used)
1.12	SYSTEM STARTUP	(Not Used)
1.13	INSTRUCTION OF OWNER'S PERSONNEL	(Not Used)
1.14	COMMISSIONING	(Not Used)
1.15	MAINTENANCE	(Not Used)

PART 2 PRODUCTS

2.01	MANUFACTURERS	(Not Used)
2.02	EXISTING PRODUCTS	(Not Used)

2.03 MATERIALS

A. Provide all necessary materials to perform the testing operations.

B. The CONTRACTOR shall provide potable water for conducting leakage testing for all potable water lines, flushing water lines and connected appurtenances.

2.04 MANUFACTURED UNITS (Not Used)

2.05 EQUIPMENT

A. Provide all necessary equipment, including gages and pumps, to perform the testing operations.

2.06	COMPONENTS	(Not Used)
2.07	ACCESSORIES	(Not Used)

2.08	MIXES	(Not Used)
2.09	FABRICATION	(Not Used)
2.10	FINISHES	(Not Used)
2.11	SOURCE QUALITY CONTROL	(Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Examine the areas and conditions under which the work is to be performed.

B. Notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the Work.

C. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner's Representative.

3.03	PREPARATION	(Not Used)
3.04	ERECTION	(Not Used)
3.05	INSTALLATION	(Not Used)
3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. Performance: All Work is to be performed by a firm experienced, properly manned and tooled for the test specified.

B. Conduct water, air and smoke tests as required, on all piping systems as specified below.

C. Conduct all tests in the presence of, and in a manner acceptable by the Owner's Representative or all state and local authorities having jurisdiction. Repeat tests for these authorities.

D. Repair and retest all lines, which do not pass the tests as, specified herein.

E. Inspect all valves, joints, and specialists for tightness and for proper operation while under test pressure.

F. Site Tests:

1. Drainage and Vent System Piping:

a. Perform tests either on the entire system or on successive sections of the system.

b. Tightly close all openings except the highest opening of the system or section to be tested.

c. Fill the system or section with water to the point of overflow.

d. Test with a head of at least 10 feet of water, except for the uppermost 10 feet of the system.

e. Allow water to stand in the system for at least 15 minutes before inspecting.

f. Inspect the system or section for leaks, and repair any leaks found.

2. Water Piping: Comply with the testing procedures of Section 33 05 00, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

a. Water piping shall be tested and proved tight under a pressure not less than 1 1/2 times the working pressure under which it is to be used but not less than 100 psig for 30 minutes with no loss of pressure.

b. Potable water shall be used for testing.

c. When authorities having jurisdiction are to witness tests, notify Owner's Representative and authorities having jurisdiction in writing at least 48 hours in advance of testing.

d. Conduct all tests in presence of Owner's Representative.

e. Remove or protect pipeline-mounted devices that could be damaged by the testing.

f. Provide all apparatus and services required for testing, including:

1) Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings and temporary pumping systems required to maintain OWNER's operations.

2) Temporary bulkheads, bracing, blocking, and thrust restraints.

g. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of Owner's Representative. Repair of existing piping will be paid as extra work.

3. Air Test:

a. Attach air compressor testing apparatus to any suitable opening after closing all other inlets and outlets. Force air into system until there is a uniform gage pressure without the introduction of additional air. Below is a list of required gage pressures:

1) Drainage and Vent Piping (substitute for water test) 5 psi for 15 minutes.

2) Gas Piping:

a) Test gas piping under a pressure not less than 100 psig for a 1-hour duration. Duration time period to be measured after stabilization of the testing medium.

b) All joints, fittings, valves and other potential leak sources shall be swabbed with a leak detecting solution.

c) A calibrated pressure gauge having maximum increments of 2 psi shall be used.

d) Only temporary weld-end dished-head caps or threaded-endcaps, swell plugs or compression end caps (2-inch maximum) are to be installed during pressure test operations.

e) No compression couplings larger than 2 inches shall be included in the pressure test inside buildings unless they are adequately blocked or anchored to prevent pull-out from thrust forces. All piping shall be securely anchored or blocked to prevent movement or blowouts.

f) Do not include meter, regulator and final service tee at main in leakage test. This equipment should be leak tested at service line pressure.

g) All gas distribution piping shall be pressure tested in accordance with the requirements of the local municipal authorities and local utility company after compliance with the testing procedures set forth in this Specification are met.

4. Smoke Test:

a. Finished Plumbing: Final test for gas and water tightness of the completed drainage and vent system:

1) Fill all traps with water.

2) Introduce a pungent thick smoke, produced by one or more smoke machines, into the system.

3) When the smoke appears at stack openings on the roof, close the system.

4) Maintain a pressure in the system equivalent to a 1-inch water column for the period of the inspection.

5) Inspect the system for leaks and repair any leaks found.

5. Peppermint Test can be substituted for the final Smoke Test of the drainage and vent system as allowed by the local building and plumbing codes.

3.11	ADJUSTING	(Not Used)
3.12	CLEANING	(Not Used)
3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 40 60 01 - PUMP STATION CONTROL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes all elements required to furnish and install a complete electrical control system to control, operate, and display information as indicated in the plans and specifications. The control system shall include all equipment, devices, wiring, and incidental materials to operate the system and display or relay information in accordance with these specifications. The intention of this section is to secure a complete control system that will operate equipment in accordance with narratives and requirements indicated in the plans, specifications, and manufacturer's literature for the equipment installed. All circuits and devices for protection of installed equipment shall be included in the lump sum bid.

1.02 SCOPE OF WORK

A. The contractor shall furnish and install with each pump station, one control panel. The pump station control panel shall house the complete electrical system to operate the pump station. The control panel shall be manufactured by a UL certified panel facility and shall meet all UL698A standards (Industrial control equipment with circuit extensions into hazardous locations). All components shall be UL recognized or listed including those supplied by the pump manufacturer and the control panel shall house all necessary controls including circuit breakers, and other equipment specified herein. The enclosure(s) shall be built to meet NEMA ratings (Controls compartment), (Service and MCC compartments), and shall in all respects conform to the National Electric Code and all other state and local codes which may apply.

1.03 DEFINITIONS

A. AIC – Amps Interrupting Current is the maximum current that is produced upon a fault to ground or a fault between phases.

B. Arc Flash – An electrical explosion that can occur when there is an uncontrolled conduction of electrical current to ground or to another phase. An Arc Flash occurs very rapidly and produces intense heat and energy that can harm personnel and destroy equipment.

C. Control Compartment – A compartment or enclosure in the control panel assembly that contains all control components of the pump station including the PLC (controller), communications and other devices.

D. FLA – Full Load Amps

E. GFCI – Ground Fault Circuit Interrupter

F. GPM – Gallons Per Minute

G. HMI – Human Machine Interface

H. HOA – Hand-Off-Auto operator switch

I. kW – Kilowatts (power)

J. MCC – Motor Control Center

K. MCC Compartment – A compartment or enclosure in the control panel assembly that contains components related to motor starting. Some components include variable frequency drives, pump breakers, the control power transformer, and the voltage monitor.

L. Service Compartment – A compartment or enclosure in the control panel assembly that contains service entrance or incoming power feeder equipment for the station. Some components include main incoming terminal blocks, main service or incoming feeder circuit breaker, and phase monitor and other protective devices.

M. PID – Proportional Integral and Derivative

N. PLC – Programmable Logic Controller

O. Skirt Compartment – A vented compartment, enclosure, or wireway under the control panel assembly that is reserved for routing of cables into various compartments.

P. UPS – Uninterruptable Power Supply

Q. VFD – Variable Frequency Drive

1.04 REFERENCES

A. ANSI®/NFPA® 70 – National Electrical Code® (NEC®)

B. IEC 61000 – Electromagnetic Compatibility

C. NEMA 250 – Enclosures for Electrical Equipment

D. NEMA ICS7 – Industrial Control and Systems Adjustable Speed Drives

E. UL® 50 – Enclosures for Electrical Equipment

F. UL 98 – Disconnect Switches

G. UL 507 – Electric Fans

H. UL 508 – Industrial Control Equipment

I. UL 508C – Power Conversion Equipment

J. UL 698A – Circuit extension into hazardous locations

K. UL 991 – Safety Tests

L. IEEE-519 – Harmonic levels

M. NFPA 70E – Electrical Safety

1.05 SUBMITTALS

A. Shop Drawings

1. The Engineer reserves the right to approve or disapprove any and all equipment based upon evaluation. Approval for fabrication and installation will be made only after submittal and review of all shop contract documents. The information required for approval shall include the following items and be provided to the Engineer for approval.
    a. Electrical schematics
    b. Enclosure dimensional drawings
    c. Complete layout drawing with dimensions
    d. Environmental calculations in MCC compartment
    e. Environmental calculations in Control compartment
    f. Manufacturer data sheet for all components
    g. Complete bill of material
    h. User operating manual
    i. Installation instructions
    j. 2 year warranty certificate

B. All submittals shall be made in electronic PDF format, in addition to any other format required by other specification sections.

1.06 SUBSTITUTIONS

A. The Engineer will consider proposals for substitution of materials, equipment, methods and services only when proposals are accompanied by full and technical data and all other information required by the Engineer for the proposed substitution. Substitution of materials, equipment, methods and/or services is not allowed unless such substitution has been specifically approved by the Engineer. The Contractor shall allow 15 days for approval after receipt by the Engineer.

1.07 QUALITY ASSURANCE

A. Control panel

1. Control panel shall be manufactured in a UL508A facility and be UL certified to manufacture panels with UL698A intrinsically safe components.
2. Factory shall conduct full operational tests with appropriate voltage applied to the panel.

1.08 DELIVERY, HANDLING, STORAGE

A. All materials relating to this section individually and as completed panels shall be handled as fragile equipment and stored only inside closed buildings and protected from moisture entry. All openings shall be continuously sealed until the moment that connections thereto are actually made.

1.09 WARRANTY

A. Warranty: 24 Months from date of manufacture. The warranty shall apply to being free of defects in material and workmanship.

PART 2 - PRODUCTS

2.01 ENCLOSURE

A. The enclosure shall be one freestanding enclosure consisting of four different compartments within one footprint, or one assembly of four separate enclosures mounted on a common support frame with all enclosures connected flush or with pipe nipples, or, where installed indoors, the enclosure may consist of separate freestanding or wall mounted enclosures connected together as necessary by conduits or wireways.

2.02 COMPARTMENT REQUIREMENTS

A. The Service compartment shall house the main service power components.
   1. This compartment function is satisfied by the service entrance rated automatic transfer switch for this project.

B. The MCC compartment shall house the motor starter components.
   1. This compartment may be a separate motor control center assembly for this project.
   2. This compartment may be separate enclosures for VFD's for this project.

C. The Control compartment shall house all controls associated with the panel. The maximum voltage within this compartment is to be 120vac.

D. The Cable entrance compartment is a nonrated vented compartment that provides an area for the entry of cables from the wet well. All cables with the exception of line power will come through the cable entrance compartment.
   1. This compartment is not necessary for control panel assemblies installed indoors.

E. Conduit and mounting template – A drawing shall be provided with each enclosure to provide anchoring locations and conduit locations entering the enclosure. This drawing shall be available at the time of conduit and foundation layout.

2.03 ENCLOSURE CONSTRUCTION

A. All compartments are fabricated as one complete unit with singular common separation walls resulting in one complete enclosure, or as separate enclosures connected flush or with pipe nipples and mounted on a common frame, or, where installed indoors, as separate enclosures connected by conduits or wireways. The NEMA Type rating integrity of each compartment or enclosure shall be maintained at all times from the factory manufactured enclosure through final installation.

B. The entire panel enclosure when mounted indoors shall be NEMA 12, painted steel.
   1. When the indoor mounting is inside a room dedicated to electrical equipment, with no process piping, the panel enclosure(s) may be NEMA 1, painted steel.

C. Interior wall construction: all common walls shall consist of one sheet of painted steel with a minimum 16-gauge thickness, or 14-gauge where any dimension is greater than 24 inches.

D. Interior mounting: all mounting plates, hinges and other components mounted onto the enclosure walls shall be held in place by stainless steel studs.

E. Exterior door handles to be steel powder coated black. Door handles to be fully lockable and able to accommodate a #21 Master padlock. Each door handle must be NEMA Type rated to maintain the rating of the associated compartment.

F. Exterior door hinges shall be continuous steel piano type hinges.

G. Mechanical door stops shall be mounted on the Control and MCC compartment doors to secure the door in the open position at 110 degrees. Door may be closed by manually lifting up on the door stop arm. They shall be located at the bottom of each cabinet door.

H. A fold out aluminum 3-ring binder shall hold the Electrical schematic and all job specific documentation. All documentation shall be laminated

I. Back panels shall be constructed of polished aluminum, .125" thick minimum, or painted or stainless steel, 12-gauge minimum. Back panels shall have ½" mounting hole at a minimum at each corner. Back panels are to be mounted to the enclosure with a minimum of 3/8" studs and nuts.

J. The Control compartment shall have a dead front inner door for mounting the controller, indicators, and switches. The inner door shall be constructed out of 12-gauge steel, minimum. The door shall be mounted to the enclosure via a continuous steel piano hinge. Two twist lock latches are to be used to secure the inner door in the closed position. The latches are to be T-handle type constructed from polyamide-6 nylon plastic 30% glass reinforced material or material of equal durability. They shall be mountable through square holes to prevent rotation of the entire mechanism.

2.04 GENERAL ENCLOSURE REQUIREMENTS

A. The reduction of the Arc Flash potential shall be reduced by isolating high voltage into specific compartments.

B. The Service and MCC compartments may contain components that operate at a voltage that is capable of creating an Arc Flash condition. Personnel Protection Equipment (PPE) is required. Accessibility should be limited to qualified electricians only.

C. The Control compartment only contains control voltage (maximum of 120vac). Minimal Personnel Protection Equipment (PPE) is required for operators and maintenance personnel. See NFPA 70E for proper PPE requirements.

D. All penetrations through compartments shall be performed to maintain the NEMA Type ratings of each individual compartment.

E. The enclosure shall be constructed so that no screws or bolt heads are visible when viewed from any external portion of the enclosure.

F. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

G. No holes shall be drilled in the top (rain cap) of the cabinet.
   1. This is not applicable for indoor cabinets.

H. Electrical schematic shall be permanently affixed to inside of the outer door of the Control and MCC compartments. The schematic shall resist water and prevent removal and discoloration from heat, gasses, and ultraviolet light.

2.05 SERVICE COMPARTMENT COMPONENT AND REQUIREMENTS

A. Reference Transfer Switch specifications.

B. Surge Protective Device
   1. Provide surge protective devices (SPD's) as shown on drawings and per specifications.

2.06 MCC COMPARTMENT COMPONENT AND REQUIREMENTS

A. Door interlock
   1. An electromechanical door interlock shall prevent access into the MCC compartment unless the main power is disconnected. The MCC compartment door interlock mechanism is powered through a two-pole circuit breaker in the MCC compartment. A defeater mechanism shall be provided, or the main power must be able to be connected while the MCC compartment door is already opened by a qualified electrician with appropriate PPE.

B. Pump circuit breakers
   1. Pump circuit breakers shall be thermal-magnetic or electronic trip molded case breakers. Individual pump circuit breakers shall be sized according to the VFD manufacturer, NEC and the FLA of the pump.

C. Control transformer primary circuit breaker
   1. The control power circuit breaker shall be sized according to the rating of the primary windings of the control power transformer. The line side of the circuit breaker shall be supplied from a tap from the load side of the main circuit breaker. It shall be DIN rail mounted and adjacent to the MCC Compartment door interlock circuit breaker.

D. Door interlock circuit breaker
   1. MCC compartment door interlock circuit breaker shall be a two-pole 10-amp circuit breaker and supplied from a tap from the load side of the main circuit breaker. It shall be DIN rail mounted and adjacent to the control power circuit breaker.

E. Control power transformer
   1. A control power transformer is only required on stations that do not provide 120 volts to a service neutral.

F. Variable Frequency Drives
   1. Reference variable frequency drives specifications section.

G. Environmental Control
   1. MCC Compartment shall be furnished with insulation, air conditioner, exhaust fans, and/or ventilation louvers as necessary to maintain environmental conditions inside the compartment suitable for its components.
   2. A thermostat shall be mounted in the MCC compartment and operate the fans or air conditioner on rising internal temperature. The thermostat shall be mounted in the lower half of the MCC compartment in order to avoid short cycling.
   3. All environmental control components shall be selected to maintain the NEMA rating of the MCC compartment.
   4. Heat load calculations and other calculations used to select the environmental control equipment shall be included with equipment submittals.

H. MCC may be a separate control panel with motor starting components installed or a separate MCC style assembly or separate VFD enclosures for this project.

2.07 CONTROLS COMPARTMENT COMPONENT AND REQUIREMENTS

A. Operator Interface Terminal (OIT)
   1. 320x240 minimum resolution backlit LED display
   2. Memory: minimum 256 MB RAM
   3. NEMA 4 display rating
   4. Manufacturer: Multismart pump station manager by Multitrode or approved equal.

B. Pump Controller
   1. This pump station effectively consists of two different pump control systems: a duplex (max one pump running at a time) low flow pump system and a triplex (up to two pumps running at a time) duty pump system.

a. Pump station controls may be achieved by programming a single controller to perform all functions, or by using two separate controllers to effectively separate low flow and duty pump control schemes.
b. Reference pump level control schedule on drawings.

2. Programmability
   a. The pump controller shall provide user ready automatic control of pumps with an intuitive HMI interface. The pump controller shall contain pre-designed operational parameters that are selected and configured via the OIT.
3. Minimum Features
   a. Pump control of up to six pumps, including pump grouping and pump alternation.
   b. Intelligent Hand-Off-Auto control.
   c. Level set point adjustment for pump activation, deactivation and station level alarms.
   d. Level device input capability shall include: 4-20mA analog signal, conductive probe or floats.
   e. Redundant level device input capability with automatic input fault control (input device switching).
   f. Selectable charge (fill) or discharge (empty) modes.
   g. Pre-configured station optimization features including: maximum pump off time, maximum pumps to run, maximum starts per hour, inter-pump start and stop time delays, maximum pump run time, blocked pump detection, well washer control capability, well clean out control capability, pump operation control (profile programming) capability.
   h. Locked level alarm function to indicate a level device fault.
   i. Pump alternation modes.
   j. Pump decommissioning.
   k. Up to six unique user defined profiles of set points shall be available to control pumps during specific site conditions or events.
   l. Datalogger for user-defined faults and events.
   m. Supply voltage monitoring and supply fault management.
   n. Monitoring of DC power supply, battery voltage, and internal controller temperature.
   o. Energy, power, and pump efficiency monitoring.
   p. Motor protection features including: current monitoring for each pump, over- and under-current trip, ground/earth fault, current phase imbalance fault, i2t fault, and insulation resistance testing for motor windings.
   q. Flow measurement: calculated flow via liquid level draw down data.
   r. VFD speed control capability.
   s. Fault module capability as follows: pump hold out function, automatic restart function after fault condition is no longer present, manual reset of fault required (if user intervention of fault reset is selected).
   t. Remote control via remote telemetry monitoring including security.
   u. SD/USB ports shall be available for the following operations: firmware upgrades, save and load pump controller configuration, download data logs, export or import Modbus and DNP3 points list.
4. Functionality
   a. Pump mode: For each pump, operator shall have one hand-off-auto switch to locally start and stop each pump. Control from the pump controller shall be disabled if the physical selector switch is not in the auto position. In remote auto, pump shall operate as described in the automatic sequence below. Pump shutdown alarms shall be active regardless of the selected mode. Any time a pump is returned from hand or off to auto, pump shall transition to remote automatic mode, e.g. from power failure, and become available to be called to run by the controller.
5. Automatic Control

a. The operator shall have the ability to enable and disable automatic pump role alternation.
b. In the event of a controller or level transmitter failure, emergency backup floats will attempt to start and stop both pumps (one at a time) on a hardwired basis. Any faults that can be detected by logic shall be generated, e.g. level sensor failure, high-level set point activated, emergency pumping circuit activated.

6. All level set points for operation and alarms shall be adjustable from the display or remotely, meaning the user can choose what levels trigger each condition.
7. All monitoring and alarm signals shown with contract drawings shall be displayed on the display and remotely for monitoring and troubleshooting purposes. All alarms shall be programmed to latch upon alarm condition, and shall require acknowledgement either at the display or remotely in order to reset the alarm.
8. Communications
   a. Physical - The pump controller shall include the following data communication ports:
      1) Two ethernet ports (10 Mb/s)
      2) Two RS232 ports (115 Kb/s)
      3) Two RS485 ports (115 Kb/s)
      4) USB device port
      5) SD card port
   b. Communications Types - The pump controller shall support the following communication types:
      1) TCP/IP
      2) UDP
      3) RS232
      4) RS485
      5) Private radio over RS232
      6) PSTN
      7) Wireless LAN
      8) Cellular data via integral PPPM module
      9) Cellular voice
   c. Communications Protocols
      1) DNP3 (master and slave, level 2 compliant), including: change of state monitoring, native date/time and quality stamps for each data point, event buffering for different classes of data, support for multiple masters and slaves to be configured on the unit, and DNP security (for securing communications between master station and RTU).
      2) Modbus (master and slave), including: Modbus TCP, Modbus RTU, Modbus ASCII, and support for multiple masters and slaves.
9. Manufacturer
   a. Multitrode Multismart Pump Station Manager with PumpView3 with a cellular connection or approved equal.

C. Cellular Communications Equipment
   1. Provide cellular communications modem, power supply, antenna, and first two years' service provider contract.
   2. Coordinate provider to be used with owner.
   3. Cellular equipment may be integrated as part of the RTU.
   4. Provide external antenna (if necessary) with surge suppressor.

D. Remote Terminal Unit (RTU)
   1. RTU, to be provided in addition to pump station controllers, shall be a High Tide model HTT-900 with cellular capability and antenna, or approved equal.
   2. RTU shall include high level backup functionality.

a. This functionality shall only be required to control duty pump operation as needed for high level backup.
b. Low flow pump backup control is not required, but may be provided.

3. RTU shall be set up to provide pump station monitoring per owner's preferences for data transmitted. Coordinate with owner for all data points required.
4. General: RTU's shall be A/C or Solar powered depending on the model, as designated by the Owner. The RTU's shall be available as either a kit that can be mounted in existing cabinets or supplied in a NEMA 4X enclosure with a raised door supported by stainless steel hinges on the left and a stainless steel latch configured for a padlock (supplied by Owner). The electronic components provided shall be din-rail mounted for easy replacement without removal of the enclosure. AC power supplies and solar regulators shall be modular and easily replaceable in the field. Provide RTU with 120VAC surge suppressor.
5. Back-up battery power shall be provided in the event that AC power is lost. When in battery backup mode the unit will at a minimum have enough power to send out a power fail alarm and maintain full control functionality for up to 18 hours.
6. The Manufacturer shall have the following types of RTU's available or equivalent:

Option	DI's	AI's	DO's	AO's	Networks
HTT201	2				Cellular
HTT900	12				Sat, Cell, IP
HTT1100	8	4 inc + 4 opt	4 opt.		Sat, Cell, IP
HTT3100	28	6 inc + 4 opt	4	2	Sat, Cell, IP
HTT4100	28+	12+	8	opt.	Cell, IP
GPG	2				Mesh Radio

a. Solar power shall be available as requested for HTT201 and HTT1100.
   1) Solar power options include 10W,20W,60W,120W power systems. Each of these is chosen based on the application and external I/O drain requirements.
   2) Batteries for each of the solar power options is also sized appropriately between 10Ah and 180Ah capacity.
b. Back-up battery power shall be available for all but HTT4100 and GPG in the event that AC power is lost. When in battery backup mode the unit will at a minimum have enough power to send out a power fail alarm and on some options actually maintain full functionality for a small number of days.

7. The Manufacturer shall have the following types of Inputs and Outputs available:
   a. Digital inputs compatible with either open collector or dry contact sources. Optional 115V or 230V instrumentation relays to mount in the enclosures when required.
   b. Counter inputs. Four of the digital inputs configurable as pulse counters for flow monitoring equipment or rain gauges.
   c. Analog inputs configurable to accept either 0-5V or 4-20ma and 0-20ma inputs. For 4-20ma and 0-20ma inputs, the sense resistor shall be 250ohms and removable for voltage sensors. 4-20ma inputs configurable to accept 2-wire, 3-wire or 4-wire sensors. Battery backed up 24V loop power shall also be available as well as analog inputs with optional integrated surge protection available.
   d. Digital Outputs. RTU's with digital outputs configured with din-rail mounted Form-C relays capable of switching up to 5A at 250V.
   e. Analog Outputs. RTU's with analog outputs capable of syncing 4-20ma outputs under RTU control.
   f. Modbus Master. At least one type RTU shall have an RS-232 port that can be configured as a Modbus Master for reading data from third-party PLC or sensor equipment.

8. Two-way Communications: The RTU shall have capability to both send alarms and scheduled reports up to the server as well as receive commands from the server at any time. All functional configurations and alarm thresholds shall be able to be sent from the server without visiting the RTU.
9. Digital Alarm Functions: The RTU shall be able to report status changes or alarms on any digital input. All analog inputs may be configurable as digital or alarm inputs.
    a. Pseudo alarms shall be available to report when two or more selected digital inputs are in the alarm state at the same time.
    b. Whenever a digital alarm occurs the status shall be reported to the server after a programmable validation delay.
10. The RTU shall have the following Analog Input Monitoring Functions:
    a. Reports analog input levels on programmable schedules ranging from 1 min to several hours.
    b. Ability of the user to configure up to four separate alarm thresholds for each analog input. The RTU shall send an extra report to the server whenever the analog level passes through any of the alarm thresholds. Alarm thresholds shall be continuously monitored regardless of the reporting interval.
    c. Ability to configure the RTU to sample the analog input only when one or more digital inputs are active. This may be used to monitor pump amps or flow rate only when a pump is running.
    d. Ability to report an alarm when an analog reading falls too rapidly such as tank level falling due to system leak.
11. Local Pump Alternator/Controller. The RTU shall include a software pump controller with the following functions built in and configurable over the communications channel:
    a. Local control for up to three pumps.
    b. Local alternation, lead lag or round robin control behavior.
    c. A maximum number of pumps running setting that actively turns off pumps to stay below the maximum.
    d. Back up timers that can be set for maximum ON time or maximum OFF time or both. The maximum on setting can be configured to turn all pumps off or to force alternation.
    e. Ability to set a time of day where the RTU turns pumps ON for a fixed duration of time.
    f. Alarm the server if a pump is called for but does not start.
    g. Ability to turn a pump ON or OFF based on local analog input alarm thresholds. This can be used for functions like low suction cut-off, local altitude valve control or local alarm light activation.
    h. Ability to run all three pumps at once at the emergency pump level.
12. Flow Meter Functions. The RTU shall support the following features associated with flow meters:
    a. Four internal 32-bit pulse counters stored in non-volatile memory.
    b. Ability to report the counter totals on intervals ranging from 1 minute to daily.
    c. Ability to convert two of the counter inputs pulse rates to a flow rate and report to the server in the form of an instantaneous flow rate reading.
    d. Ability to take two of the Analog inputs connected to flow rate outputs of meters and integrate the signal to create a pseudo totalizer simulating a pulse counter. This will be used when pulse outputs are not available from the flow meters.
13. Rain Gauge Monitoring. The RTU counter inputs shall be able to support tipping bucket rain gauge instruments with the following reporting features:
    a. Ability to report rainfall in 15 min resolutions.
    b. Graph rain on the web interface in hourly, daily and monthly increments.
14. Water/Wastewater Pump Station Functions. The RTU shall support the following pump station monitoring functions:

a. Ability to accumulate and report start and runtime statistics for up to five pumps. The statistics may be scheduled to report to the server on intervals between hourly and daily.
b. Ability to report an alarm if a single pump run cycle exceeds a threshold set by the user.
c. Optional flow estimation based on wet well geometries and pump on/off levels.
    1) Works for either float or level based installations
    2) Pump Capacity calculation
    3) Station output flow rate and totalization
    4) Station inflow rate estimation

15. Power Monitoring. The RTU shall support the following power related functions:
    a. All units shall have battery backup that keeps the core functions active for at least two days. Depending on what option is installed, some I/O's will continue to function normally.
    b. Alarms shall be sent to the server when power loss is detected.
    c. For solar RTU's or A/C powered RTU's running on battery, alarms shall be sent to the server when the battery reaches a critical low level. Solar units shall also report if no charging voltage is received for 4 days as an indication that the panel may be stolen or defective.
16. Ease of Replacement. Main electronics' modules shall have the following features:
    a. Main electronic modules shall be din-rail mounted for easy removal and replacement.
    b. All power and I/O connectors shall be two-part pluggable terminals so that when a module is replaced no wires have to be removed from the terminals.
    c. The same basic RTU shall be used for all communications options with no I/O configuration changes.
17. Antenna Options:
    a. Cellular options shall include an antenna that is internal to the enclosure, an omnidirectional antenna external to the enclosure or a directional (higher gain) antenna external to the enclosure.
    b. Satellite RTU's shall require an external 3-inch stub antenna with a bracket and either a 15, 30 or 50-foot external cable.
    c. IP units shall only require standard 10baseT RG6 Internet patch cable connection.
18. Expansion and Accessories. The RTU's shall have the following optional factory-installed accessories available:
    a. Din-rail mounted main power surge arrestor.
    b. Din-rail mounted Analog or Digital signal surge arrestors.
    c. RTU's with four Analog inputs shall have an optional expansion module to add four additional 4-20ma analog inputs.
    d. Enclosure heaters and thermostats.
    e. Local digital displays for analog inputs.
    f. RTU's with a programming port through which qualified installers may upgrade internal software without returning the equipment to the factory.
19. Communication Platforms:
    a. RTU's may be configured with either low earth orbit satellite (Iridium), GSM cellular (ATT or International), CDMA cellular (Verizon) or IP (Internet) as designated by the Owner to communicate bi-directionally from the RTU to the Central Server.
20. Customer Service:
    a. The Manufacturer shall provide 24-hour, seven days a week phone support access to the Owner by the Manufacturer's customer support personnel. Customer support personnel shall provide assistance with software, communications and hardware as required by the Owner. The Manufacturer shall provide the Owner with a toll-free number to contact their customer support personnel. No additional fees shall be

charged by the Manufacturer for configuring the Owner's software for their applications.

E. Application Programming
   1. Provide all required application programming and/or configuration for a fully functional pump station controller as shown on the drawings and as specified herein.
   2. Supply Operator Interface Terminal (OIT) application programming and/or configuration to provide control of the pump station controller/telemetry panel locally. The OIT shall provide complete monitoring and control of all equipment at the pump station. At a minimum OIT programming/configuration shall include monitoring and control of:
      a. Running / stopped / alarm status of all pumps, including individual alarms and manual or automatic status control for each pump.
      b. Automatic / lead / lag switching for each pump.
      c. Emergency pumping circuit activated.
      d. Wet well levels.
      e. AC power status.
      f. Intrusion detection.
      g. All other functionality indicated on the drawings.
   3. All application programming features described above shall also be programmed to be available from the central SCADA system web interface.

F. DC Power Supply/UPS
   1. The power supply shall convert 120 Vac to 24 Vdc power for control circuits and supply an uninterrupted 24Vdc power via a battery if 120Vac is lost. The power supply shall have dual output: One 24Vdc output for the control circuitry, the other for charging the battery.
   2. The power supply shall have the following characteristics:
      a. Output minimum 155 watts
      b. Over current protection
      c. Over voltage protection
      d. DC voltage adjustment
      e. Short circuit protection

G. Battery
   1. The battery backup power shall consist of two 12 VDC batteries configured in series to provide an output voltage of 24 VDC. A fuse link shall be installed in the circuit between each battery to provide overload protection. The batteries shall have a minimum rating of 7 amp hours.

H. Over Temperature and Seal Fail Monitoring Relay
   1. The relay shall be compatible with the pump that is installed in the wet well.
   2. There shall be one relay per pump that is present in the system.
   3. The relay shall have the following requirements:
      a. Molded relay bezel to allow for door mounting.
      b. Power on light.
      c. Over temperature and Seal Leak fault light. Color: Red.
      d. Selector switch for Auto or Manual mode. This switch shall allow the user to select between automatic or manual reset of the heat sensor fault.
      e. Provide an over temperature reset pushbutton for Manual reset mode.
      f. Seal fail sensibility to be adjustable between 4.7K ohm to 100K ohm via an adjustable potentiometer.

I. Intrinsically safe barrier
   1. The intrinsic safety barriers shall be DIN rail mounted and located in a UL approved isolated Safety Barrier location. The intrinsic safety barriers shall be used to limit the amount of energy available to all level sensing circuits in the wet well in order to prevent sparking.

a. Analog IS barrier
b. Back up float switches IS barrier

J. Control circuit breakers
1. The control circuit breakers shall be located in the Control compartment and used to protect all 120 volt and 24 volt circuits. The 120 volt circuit breakers shall be supplied by the secondary side of the control transformer (unless 120 volts is available from the main electrical service).
2. There shall be six single pole control circuit breakers as follows:
a. Main control power
b. Fan
c. GFCI Receptacle
d. Heater
e. Crane
f. Control wiring
g. 24vdc Power supply

K. Control Relays
1. Control relays shall have the following characteristics:
a. 4 pole, 8 A, 1/3 hp (IEC rating = 6 A)
b. Coil: 120 VAC or 24 VAC
c. DIN rail mounting
d. Terminal screw type socket
e. Voltage rating: 300 volts
f. Mechanical status flag
g. Pilot light indicating status
h. Manual operator
i. Protection module mounted in base (diode, RC circuit or varistor)
j. Metal hold down clip
2. Components shall be Square D, Zelio Relays P/N-RXM4B1F7, Hold down clips P/N-RXZ400, Relay socket P/N-RXZE2M114M.

L. Environmental Control
1. Controls compartment shall be furnished with insulation, air conditioner, exhaust fans, and/or ventilation louvers as necessary to maintain environmental conditions inside the Control compartment suitable for its components.
2. A compartment heater shall be supplied and mounted at the bottom portion of the Control compartment. The heater shall be positioned away from any heat sensitive components directly above the heater. Construction should be vulcanized fiberglass-reinforced silicone rubber encapsulating a nickel alloy heating element with an integrated thermostat.
3. All environmental control components shall be selected to maintain the NEMA rating of the Control compartment.
4. Heat load calculations and other calculations used to select the environment control equipment shall be included with equipment submittals.

M. Utility receptacle
1. A GFCI receptacle shall be mounted on the Control compartment inner door. The receptacle shall be rated at 15 amps, but restricted to 7 amp service by a dedicated 10 amp 120 VAC circuit breaker. The circuit breaker shall be supplied from the secondary of the control transformer.

N. Selector Switches
1. Switches shall be mounted on the Control compartment inner door. The switches shall have extended operator handles.
a. HOA Switches

1) There shall be a HOA selector switch for each individual pump. When in Hand, the pump shall run at a preset speed. In the Off position, the pump will neither run in the auto or manual mode. When in Auto, the pumps will cycle per the commands of the controller.

b. ON-OFF Light Switch

1) There shall be a ON-OFF selector switch to allow the operator to turn on and off the cabinet lights. This switch is to be mounted on the inner door.

O. Indicator Lights

1. Alarm lights shall be mounted on the Control compartment inner door. There shall be two alarm lights; High-Level light with a yellow lens, and a Low-Level light with a yellow lens.
2. The pilot lights shall be minimum 22 mm in diameter 24Vdc.

P. Push Buttons

1. An alarm test button shall be mounted on the Control compartment inner door. The alarm test button activates both the horn and strobe light to ensure proper operation.
2. An alarm silence button shall be mounted on the side of the enclosure below the horn/light assembly. When pressed, the silence button will silence the audible alarm. The audible alarm will latch in silence mode until all alarms are reset and there are no longer any alarm conditions.

Q. Audible and Visual Alarm

1. An alarm horn and red strobe beacon shall be mounted on the outside of the Control compartment and be activated on High-level or common alarm from the controller. If the audible is silenced, the alarm light will continue to flash until the alarm condition is cleared. The red strobe beacon should be mounted in a way that it is visible from 180 deg. around the panel.
   a. Voltage shall be 24Vdc. and operate on the UPS power circuit in case of main power fault.
   b. The horn and light assembly shall be sealed as one part from the manufacture and be rated at NEMA Type 4X.
   c. Lens Color: Red
   d. Horn to be a minimum of 100dB

R. Radar Level Transducer

1. Provide per Section 40 72 00 Level Measurement.
2. Use for primary control of pumps.
3. If two separate pump station controllers are used, connect the single level transducer's 4-20mA loop to both controllers so they both may use the same transducer level signal.

S. Float switches

1. Provide per Section 40 72 00 Level Measurement.
2. Use for back-up control of pumps.
3. If two separate pump station controllers are used, connect the applicable floats to both controllers by use of interposing relays so they may both use the same floats.

2.08 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

A. The SCADA system used shall be manufactured by High Tide Technologies, LLC, or approved equal.

B. Qualifications

1. The SCADA System shall be furnished by a single Supplier who shall assume responsibility for providing a complete and integrated system.
2. Manufacturer must have been regularly engaged in the supply of SCADA equipment for at least 10 years and must be capable of meeting the following criteria:
   a. Have completed a minimum of three (3) satellite telemetry systems and three (3) cellular telemetry systems.

b. Provide the Owner with reference names and phone numbers for a minimum of two Satellite Telemetry System customers and two Cellular Telemetry system customers.
c. Acknowledge that shipment of the SCADA RTU units and related equipment shall be authorized only by the Owner.
d. Utilize only UL listed and rated components in enclosure manufacture.
e. Provide 100 percent of all hardware and software technical manuals to the Owner in digital format (Adobe PDF).
f. Provide a complete bill-of-materials (BOM) and enclosure layouts that are numerically cross-referenced together for each SCADA unit. The BOM shall contain the standard factory supplied part numbers instead of proprietary numbers.
g. Provide a warranty and customer support for a period of not less than one (1) year after the Owner accepts each SCADA unit.
h. Provide primary technical support to the Owner by full-time qualified staff members only.

3. Central Server
   a. The Central Server core shall be configured as a cluster of servers, each performing different tasks. Key functions shall be running on multiple servers thus providing redundancy in the event of hardware failures. The entire cluster shall be hosted in a server-hosting center with power, network and hardware redundancy built in.
4. Web-Based User Interface Software
   a. Compatibility: The system shall be compatible with modern web browsers on various operating systems including computers, tablets and smartphones.
   b. Access and Security: Access to the customer's user interface shall begin with a username and password screen. The web interface shall utilize fully encrypted data and passwords via standard HTTPS technology - the same level of security used by online banking applications. The person designated by the Owner as the "administrator" shall have authority to manage usernames and passwords as well as control and change certain parameters related to their system.
   c. Levels of Access: Four levels of access shall be provided. VIEWERS shall only have permission to view the system data. OPERATORS shall be able to view and acknowledge alarms. SUPERVISORS shall be able to perform all the functions of the operators as well as change parameters in the system and manually turn pumps on and off. ADMINISTRATORS shall be able to perform all the functions of the supervisors as well as create and delete users from the system. Administrators shall also be able to assign which contacts will receive alarms.
   d. User Limits: The Owner shall be able to create as many users as needed and all users shall be able to be logged in simultaneously. No additional charge shall be assessed on the number of users or viewers.
   e. User Interface Types:
      1) The system shall provide options to the Owner for either tabular or graphical status representations of the installations.
      2) Larger systems shall be able to be broken down into segments or zones for easy navigation and display. Size, location and layout of objects on the screen shall be customizable by the software provider upon Owner request.
      3) The software shall be capable of showing location and status of each RTU installation on maps, given Owner supplied addresses or coordinates.
   f. The system shall have robust Alarming Capabilities, including the following features:
      1) The ability to send alarms via voice calls, text messages or emails.
      2) The ability to configure a preferred alarm delivery order with delays between each level and each operator.
      3) The ability to accept acknowledgments via voice or text at the time the alarm is delivered or via the web interface at any time.

4) The ability for users to view a list of alarm histories for each installation including which user acknowledged the alarm.
5) The ability to set any alarm recipient to be “Nagged” by calling them every 10 minutes until someone acknowledges the alarm.
6) The ability to set shifts and days off for each alarm recipient and set day and night shift alarm notifications.
7) The ability to have audible and visual alarms pop up on the computer that is logged in to the system.
8) The ability to alarm the user if the RTU has stopped communicating with the host servers.

g. Auto Refresh: The web interface shall automatically refresh when new data or alarms are reported.
h. Data Analytics and Graphing: The system shall provide various menus to allow users to view historical data on pop-up graphs. Users shall have the ability to set the time range of the graphs and zoom in to view events of the past. When a user’s mouse is held over a data point, the details of that data point shall appear on the screen.
i. Raw Data Downloads: The user shall be able to dump raw data in tabular format for offline analysis that can be imported into a spreadsheet for further analysis.
j. Report Generation: The user shall have the ability to download formatted spreadsheet reports of various functions. The software shall also provide the ability to automatically fill in the owner’s report forms in standard Excel formatted files.
k. Screen Configuration: The Manufacturer shall provide a service to configure graphic and tabular screen layouts, particular locations and sizes of graphical objects to match the customer’s requirements.
l. Service History: The system shall provide a mechanism for the user to enter freeform service history information for all RTU sites.
m. The system shall be capable of providing Automatic and Manual Controls as listed below:
1) Ability for one Tank to control one or more remotely located pump stations and valves based on tank level or system pressures. This should be performed in either round robin or lead/lag configurations.
2) Ability to automatically cause the digital input from one RTU to be replicated on the digital output of another RTU (when digital outputs are available).
3) Ability to automatically cause the analog input level at one RTU to be replicated on the analog output of another RTU (when analog outputs are available).
4) Ability for the user to set analog threshold alarms and controls and have them downloaded to the RTU. These include levels, pressures, flow rates and any physical sensor that outputs an analog signal. This feature shall apply to RTU’s with analog input capability.
5) Ability for supervisors or administrators to manually control digital outputs that are connected to valves or pumps on RTU’s that are equipped with outputs.

2.09 SEQUENCE OF OPERATION

A. Pump Operation
1. The controller(s) shall monitor the position of each pump HAND/OFF/AUTO selector switch. Only pumps in the AUTO mode shall be called to run in automatic pump operation. In HAND mode the pump shall run irrespective of the status of the controller and the wet well level, except that the pump shall not be permitted to run if the water level is below the hardwired Pumps "OFF" level float. In the HAND position the selector switch shall directly control the VFD run command and speed control shall be from the VFD faceplate controls or a separate potentiometer. In AUTO mode, the pump operation shall be based on the level of the wet well and the level set points.

2. AUTO Mode: As the level of the wet well rises above the “Low flow pump on level” a low flow pump shall start at 60Hz and run continuously until the level drops below the “Low flow pump off level”. When the level is below the “low flow pump off level” no low flow pump shall run in AUTO mode. As the level rises above the “Low flow pump on level” again, the next available pump shall start at 60Hz and run continuously until the level drops below the “Low flow pump off level”. Should the level continue to rise after the low flow pump has started and reach the “Duty lead pump on 45Hz level", the lead duty pump shall start at 45Hz and run simultaneously with the low flow pump until the level drops below the “Duty pumps off level” and all duty pumps shall stop. Should the level rise above the "Duty lead pump on 60Hz level", the lead duty pump shall increase speed to 60Hz and continue to run simultaneously with the low flow pump until the level drops below the "Duty pumps off level" and all duty pumps shall stop. Should the level rise above the "Duty lag pump on level", the lag duty pump shall start at 60Hz and run simultaneously with the lead duty pump and the low flow pump until the level drops below the "duty pumps off level" and all duty pumps shall stop. Should the level rise above the “High level alarm” setpoint, the alarm will sound and the strobe will turn on. If the level drops below the “high level alarm” setpoint, the horn and strobe will stop, but alarm shall remain in the alarm log.
3. To achieve normal AUTO mode operation, no more than one low flow pump and one duty pump should be in HAND mode or OFF at any time.
4. The system shall include interlocks to prevent more than two duty pumps to run together at the same time under any circumstances, including HAND mode.

B. Flow Monitoring
1. The discharge flow rate of each pump shall be monitored by level changes in the wet well. The controller shall be able to compute the flow rate base on fill time, discharge time, level changes and tank dimension. The flow rate shall be updated at the end of each pump cycle and displayed on the main screen in GPM. Flow monitoring shall be achieved without the use of a flow meter for cylindrical and rectangular tanks. Should a flow meter be made available, an analog input on the controller shall be enabled and the analog input shall be calibrated on the screen to display the correct GPM values.

C. Back Up Float System
1. Should the communication between VFDs and controller fail, the VFDs shall operate the pumps @ 100% (“Fallback speed”) when called to run. An alarm shall be issued.
2. Should the level transducer fail, the float switch backup system shall take over. An alarm shall be issued.
3. Should the controller fail, the pump operation shall be based on the back up float switches. Should the High Level Alarm float switch activate, two duty pumps shall run at full speed until Pumps "OFF" float switch is reached. An alarm shall be issued.
4. The Pumps "OFF" float switches shall be hardwired via relays to interrupt the enable signal to the VFD's to prevent operation of pumps if water level is not at or above the respective pumps off levels.
5. Floats should be connected via relays both to the PLC pump station controller(s) and the RTU backup controller.

PART 3 - EXECUTION

3.01 GENERAL

A. All work shall be done in accordance with appropriate Divisions and Sections and shall be performed in a workmanlike manner.

B. Perform programming or other setup required to monitor the new pump station from the High Tide (or equal) web interface and to send alarm notifications to the owner's chosen phone numbers.

3.02 FABRICATION

A. All control panels shall be shop assembled and factory tested prior to delivery to the site. Final as-built drawing shall be made to reflect all adjustments and modifications made to the system after start-up has been completed satisfactorily. All equipment and devices shall be mounted, adjusted, calibrated, and operated exactly as recommended by the manufacturer of each component.

B. Control switches, indicator lights, and other devices shall be grouped as stated in this section and in submittal package.

3.03 EQUIPMENT INSTALLATION

A. All equipment shall be installed in accordance with approved drawings and the manufacturer's written instructions.

3.04 WIRING AND TERMINATIONS

A. All wiring shall follow NFPA 72 (NEC) or NFPA 79 (Electrical Standard for Industrial Machinery) color coding scheme.

B. All wiring shall be run parallel to side walls of panels and/or in covered wiring troughs. Wires passing across hinged areas shall be protected by abrasion resistant cabling materials

3.05 IDENTIFICATION

A. All conductors shall be labeled at each end with numbers matching submittals data sheets and all wire terminations shall be identified by the component terminal numbers as shown on appropriate panel drawings.

3.06 FIELD SERVICES

A. The system supplier shall verify all connections between field devices and pump controller.

B. The system supplier shall confirm all calibrations of instrumentation connected to the pump control panel.

C. Provide control system startup and commissioning including the pump control panel and RTU/SCADA system.

D. After the above check out and system startup has been completed, the Contractor shall notify the Engineer so that system commissioning can begin.

E. The application engineering provided shall make available to the Engineer a service representative knowledgeable in the programming of the project to assist during commissioning and provide minor programming modifications. This shall be for a minimum of 40 hours. This is in addition to other contract requirements for startup.

F. Provide training for Owner personnel.

3.07 TESTING

A. Performance Verification Test: Conduct performance verification tests to demonstrate that control system maintains set-points, and that system is programmed for the correct sequence of operation. Conduct performance verification test one day after work is installed of continuous RTU systems operation and before final acceptance of work. Performance verification test shall demonstrate the following:

1. Field Testing: Calibrate field equipment and verify equipment and system operation before placing the system on-line.
2. Calibration Accuracy and Operation of Inputs Test: Check for proper calibration and operation of each input instrument. Document each reading for the test report.
3. RTU Startup and Memory Test: Demonstrate that programming is not lost after a power failure, and RTU controllers automatically resume proper control after a power failure.
4. Surge Protection: Show that surge protection, meeting the requirements of this specification, has been installed on incoming power to the digital controllers and on communications lines.

3.08 FIELD TESTS

A. Demonstrate compliance of the control system with the contract documents. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that tests are performed by competent employees regularly employed in the testing and calibration of instrumentation systems.

B. Notify the Owner of any defective products and workmanship disclosed by the tests.

C. Testing will include the field and the performance verification tests. Field tests shall demonstrate proper calibration of input devices, and the operation of specific equipment. Performance verification test shall ensure proper execution of the sequence of operation and proper tuning of control loops.

D. Test each device such that each item will function not less than five times.

E. Tests are subject to oversight and approval by the Owner.

END OF SECTION

SECTION 40 72 00 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. General. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.

1.02 DESCRIPTION OF WORK

A. General. The Contractor shall provide the labor, tools, equipment, and materials necessary to install level measurement equipment in accordance with the Contract Drawings and as specified herein.

B. Types. The types of equipment specified in this section include the following:
   1. Radar type level transmitter.
   2. Float switches.

1.03 QUALITY ASSURANCE

A. Codes and Standards. Perform all work associated with level measurement equipment in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.
   1. National Electrical Manufacturers Association (NEMA) Compliance.
   2. National Electrical Code (NEC) Compliance.
   3. Underwriters' Laboratories, Inc. (UL) Compliance and Labeling. Comply with provisions of UL safety standards pertaining to level measurement equipment. Provide products and components which have been UL listed and labeled.

B. Qualifications
   1. Manufacturer's Qualifications. Firms regularly engaged in manufacturing of level measurement equipment whose products have been in satisfactory use in similar service for not less than 3 years.
   2. Installer's Qualifications. Qualified with at least 5 years of successful installation experience on projects with level measurement equipment similar to that required for this project.

1.04 SUBMITTALS

A. General. Furnish manufacturer's product data, test reports, and material certifications as required.

B. Materials List. Submit a list of materials giving quantities, manufacturer's name, and catalog numbers.

C. Wiring Diagrams. Submit wiring diagrams showing all connections for all equipment furnished under this section.

D. Calibrations. Furnish two certified copies of calibrations.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping. Deliver equipment properly packaged and mounted on pallets or skids to facilitate handling of heavy items. Utilize factory fabricated type containers or wrappings for components which protect equipment from damage.

1.06 SPECIAL WARRANTY

A. General. The Contractor shall retain the services of factory trained service personnel to provide repair services for instruments for 1 year commencing with the time the system equipment is complete and including all repair and replacement parts needed during warranty period.

PART 2 - PRODUCTS

2.01 LEVEL SENSING DEVICE

A. Radar Type Level Transmitter

1. Type: Non-contact system using a microwave transmitter/receiver, a horn antenna and a microprocessor- based signal processor. Short pulses electromagnetic energy is transmitted through the antenna towards the surface of the material to be measured and energy is reflected back in the form of echoes. The transit time of the reflected radar signal is measured and evaluated in the signal processor. The output of the unit may be configured in level, volume or percentage fill.
2. System Performance Requirements:
    a. Accuracy:
        1) Less than 65 feet: +/- 0.46 inches or better
    b. Maximum range: 65 feet
    c. Repeatability: +/- 0.1% or better
    d. Frequency: K Band (26 GHz technology)
    e. Modulation: Pulse
    f. Power Requirements:
        1) Non-intrinsically-safe instrument: 9.6 to 36 VDC loop power
        2) Intrinsically-safe instrument: 16 to 30 VDC loop power
    g. Transmitter analog output: 4 to 20 mA, 750 ohm maximum load at 24VDC
    h. Transmitter digital output protocol: HART
    i. Operating Temperature: -40 to 80°C
3. Required Features:
    a. Antenna:
        1) Mountings: 3” 150lbs flange or mounting strap depending on installation requirements shown on the contract drawings.
        2) Horn Antenna Material: Plastic, 3” nominal size to produce 10 degree beam angle or less.
        3) Flange mounting hardware material: 316 stainless steel
        4) Max power density of less than 1 micro Watt per square centimeter at a distance of 1 meter
    b. Transmitter/Processor:
        1) Enclosure: Stainless Steel
        2) Suitable for installation in Class 1, Div1 areas where methane gas may be present. Manufacture may utilize an intrinsic safety barrier to limit power to the device and wiring to meet the electrical classification requirements.
        3) NEMA6P and IP68 rated (1 bar) for protection against dust and long periods of liquid immersion under pressure. This includes the cable connection to the instrument and cable itself to protect against submergence. Any breather holes in enclosure shall be plugged.
        4) Signal cable and connector shall be manufactures cable rated for IP68 duty similar to the transmitter housing. Cable connectors shall be designed to function in wet environment.
    c. Local indication: LCD indicating current level reading or device status messages
    d. Configuration: Programming by keypad or through digital communications imposed on the 4-20mA loop.
    e. Configuration Memory: non-volatile ROM/EEPROM
    f. Measured Value Memory: the instrument shall have an integrated measured value memory for recording up to 100,000 values. Each value shall be recorded with a date and time stamp. The measure value recorded memory shall be downloadable via the accompanying software and modem for the unit.

g. Event Memory: the instrument shall have an integrated event memory that records configuration changes, and power on/off times. The event recorded memory shall be downloadable via the accompanying software and modem for the unit. The events shall be delete protected from being erased from external software or device reset.
h. Echo Curve Memory: the instrument shall have an integrated echo curve capture memory capable of storing a minimum of 10 echo curves. The echo curves will be stored at user configurable thresholds based on the current level reading, signal quality, or device output. The echo curve recorded memory shall be downloadable via the accompanying software and modem for the unit.
i. Device firmware updates shall be made generally available on the manufactures website. The accompanying software and communication modem shall be able to update the instruments firmware.

4. Configuration Software features
   a. Radar unit shall be configured through Windows 7 (Or latest version of Microsoft client operating system) based software running on a laptop.
   b. Laptop shall be connected to instrument through USB adapter directly to instrument transmitter or through digital communication imposed on the 4-20mA, 24VDC loop.
   c. Radar echo curve analysis and adjustments. Radar unit in conjunction with the software shall be able to:
      1) Display echo curve from radar unit to 1/2” resolution or better
      2) Zoom in on selectable regions of the echo curve.
      3) Display the actual echo curve of the sensor and the false echo suppression curve.
      4) Learn in false echo curve through regions of the current curve and through user parameter entries
      5) Save echo curve for off-line analysis
      6) Update echo curve at regular intervals for on- line analysis
      7) Display statistics about transmitter logic to pick the current level from multiple echoes such as echo strength, distance, probability and relative strength to current level echo.
      8) Support manual editing of the false echo curve with greater than 10 edits possible
   d. Save radar configuration for recovery or for transmission to factory for support.
   e. Provide adjustments to advanced tuning constants in the radar to deal with high turbulence, fog or spray the unit may encounter.
   f. Configure range and scale of the device display and 4-20mA output for many options of level, standard tank volume calculations or custom user defined volume to level curve.
   g. Configure failure modes for the radar sensor to drive the 4-20mA above 20mA or below 4mA.
   h. Save radar echo curves over a period of time. Unit and software shall be able to archive these echo curve playback periods for later reference or for forwarding to manufacture for support.
5. Accessories:
   a. Programming software and adapter cables
6. Product Manufacturer:
   a. Series VEGAPULS 61 as manufactured by OhmartCorporation with local display/configuration module
   b. Compatible with PACTware configuration software and VEGACONNECT 4 interface adapter
   c. No approved equals

B. Float Switches

1. Type: Direct acting, pear shaped, eccentric weighted, displacement type liquid level sensor
2. Construction Features:
    a. Float Body: Hollow hermetically sealed, rigidly molded of polypropylene containing mechanical switch and eccentric metal weight
    b. Mechanical Switch: SPDT switch rated 10 A resistive at 120 VAC and 5 A resistive at 30 VDC
    c. Weight: Weight to cause sensor to hang straight down from cable when not immersed and only allow float to pivot when immersed in liquid of specific gravity 1.0. External weights or floats that completely rise to the surface will not be permitted.
    d. Electrical Cable:
        1) Heavy duty, 3-conductor, flexible and submersible cable, sheathed in PVC or chlorinated polyethylene rubber and connected to float and switch with watertight seal
        2) Manufacturer's continuous length cable furnished shall be of sufficient length to extend to junction box.
3. Product and Manufacturer:
    a. Model ENM-10 by ITT Flygt
    b. MilliampMaster™ by SJE-Rhombus
    c. Roto-float by Anchor
    d. Or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies. In the event any discrepancies are discovered, immediately notify the Engineer/Architect in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 PREPARATION

A. Protection
1. All equipment and materials shall be packaged at the factory to protect each item from damage during shipment and storage.
2. Provide blocking and cushioning materials to prevent damage during shipment.
3. Provide temporary lifting lugs on shipping package as needed.
4. Include approximately 1 pint of touch-up paint for each finish color in shipment.

B. Surface Preparation. The work shall be carefully laid out in advance. Where cutting, drilling, etc. of floors, walls, ceilings, or other surfaces is necessary, this work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, and at no additional cost to the Owner.

3.03 INSTALLATION

A. General
1. Install equipment as indicated in accordance with manufacturer's written instructions and in compliance with recognized industry practices.
2. Mount instruments so that they may be readily approached and easily serviced.
3. Level Measurement Installation.
    a. Coordinate the installation of level sensing devices with the process equipment and Contract drawings.

b. Install manufacturer's supplied cable between level element and transmitter. If flexible conduit is not provided or where conditions dictate, furnish and install rigid conduit sized according to manufacturer's recommendations.
c. Install ground references as required for the application.

3.04 FIELD QUALITY CONTROL

A. Inspection. Upon completion of this portion of the work, the Contractor shall provide for services of a qualified representative of the manufacturer to inspect and approve installation.

B. Tests. Upon completion of all inspections and prior to acceptance by Owner, perform field tests recommended by the manufacturer.

C. Demonstration. When all required tests have been performed and final approval has been given, a qualified representative of the supplier shall thoroughly demonstrate to Owner's personnel operation and maintenance of all items installed under this section.

END OF SECTION

SECTION 43 25 13

SUBMERSIBLE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. This section covers furnishing guiderail or pedestal mounted, single-stage, submersible, non-clog, end suction centrifugal pumping units and controls as indicated herein or on the Drawings.

B. Each pumping unit shall be complete with a close-coupled, submersible electric motor, and all other appurtenances specified, or otherwise required for proper operation.

C. Related Sections:

1. Section 05 05 01, Anchor Bolts, Expansion Anchors, and Concrete Inserts

2. Division 26, Electrical

3. Division 40, Utilities

1.02 REFERENCES (Not Used)

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1.05 SUBMITTALS

A. Shop Drawings:

1. Fabrication, assembly and installation drawings.

2. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.

3. Wiring diagrams for electric motor operators.

B. Product Data:

1. Manufacturer's literature, illustrations, detailed specifications and engineering data covering materials, parts, devices, and accessories.

2. Support design information: Submit for record purposes the weight of each pump, frame dimensions, means for lifting and transporting pump.

3. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Pump:

1) Name of manufacturer, type and model

2) Rotative speed

3) Size of discharge nozzle

4) Net weight of pump and motor only

5) Net weight with pedestal, when specified

6) Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power

b. Motor:

1) Name of manufacturer, type and model

2) Type of bearings and method of lubrication

3) Rated size of motor, hp, and service factor

4) Insulation class and temperature rise

5) Full load rotative speed

6) Efficiency at full load and rated pump condition

7) Full load current and locked rotor current

C. Maintenance and Operating Instructions:

1. Prior to equipment delivery to site, Draft O&M Manual shall be submitted and approved. Unloading, handling and storage instructions shall be included in Draft O&M. One electronic copy and one hardcopy shall be supplied in Draft format after approval.

2. At minimum, O&M Manual shall include:

a) Factory IOM Manual annotated to identify applicable and non-applicable information for the pumps provided.

b) Submittal documentation including Pump Datasheets, Design Points, and Material of Construction supplied (for Owner's reference).

c) Quality Assurance/Control Submittals as detailed below. (Allocate space in O&M and provide as Information for the Record).

D. Repair Parts and Maintenance Material: Submit a list of repair parts and maintenance material to be provided in accordance with paragraph 1.15 of this Section.

E. Quality Assurance/Control Submittals:

1. Field installation report: Furnish a manufacturer's service report after inspection of the pumps for proper installation with the following:

a) List of deficiencies in the pump installation and the recommended corrective action.

b) Statement certifying that pumps are properly installed and fully operational except for deficiencies noted.

2. Reports of Shop Testing specified in paragraph 2.11 of this Section.

1.06 QUALITY ASSURANCE

A. Pumps and appurtenances provided under this Section shall be the standard product in regular production by a manufacturer whose products have proven reliable in similar service for at least five years.

B. Manufacturer shall have a minimum of 10 years of experience producing substantially similar equipment and shall be able to show evidence of at least 5 installations of similar size and application in satisfactory operation for at least 5 years.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage framework which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:

1. Store materials in a secure location to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify Owner's Representative, in writing, if any loss or damage exists to equipment or components or if there is a deviation from the approved Shop Drawings. Replace loss

or deviations and repair damage to new condition in accordance with manufacturer's instructions.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)
1.11 WARRANTY

A. See Section 01 78 36 Warranties and Guarantees

1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL

A. See Section 01 79 10 Instruction of Owner's Personnel

1.14 COMMISSIONING (Not Used)

1.15 MAINTENANCE

A. Repair parts - Provide the following:

1. Mechanical seals: One per pump type.

2. Sets of motor bearings: One per pump type.

3. O-ring and Gasket Set: One per pump type. (Containing O-rings and Gaskets required for one Seal & Bearing change.)

4. Profile gasket (If applicable): One per pump type.

5. Impeller bolt: One per pump type.

6. Pump Monitoring Relay: One of each type of relay provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Basis of Design for the project is KSB. Other acceptable manufacturers include Xylem Flygt and Fairbanks Morse.

B. Acceptable manufacturers above must meet all design conditions and specifications. Inclusion here represents a minimum standard of quality and does not relieve the manufacturer from meeting the specifications.

2.02 EXISTING PRODUCTS (Not Used)

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Service Conditions:

1. Stormwater Duty Pumps:

a. The stormwater duty pumps are submersible, to be installed in the wet well of the pump station as shown in the Drawings. The pumps are configured to operate one to two pumps using VFD controls for start/stop.

b. Pump operation will be controlled as specified in this section and the Contract Documents.

2. Low Flow Pumps:

a. The low flow pumps are wet well submersible pumps to be installed in a sump within the wet well as shown in the Drawings. The pumps are configured to operate only one pump on and have one standby.

b. Pump operation will be controlled as specified in this section and the Contract Documents.

3. Fluid Characteristics:

a. Maximum liquid temperature: 1005°F

b. Maximum solids concentration, by weight.: 3.5%

c. Design sphere diameter: 3 inches minimum

B. Pump Performance Conditions:

Criteria	Duty Pumps [Note 1]	Low Flow Pumps
Full Speed Pump Operation		
Rated Head	50 ft	61.3 ft
Flow at Rated Head	29,000 gpm	673 gpm
Operating Head Range	15 ft - 74 ft [Note 2]	45 ft – 104 ft
Static Head at Rated Condition	26.5 ft	34.25 ft
Maximum Pump Speed	900 rpm	1800 rpm
Reduced Speed Pump Operation		
Rated Head	33 ft	-
Flow at Rated Head	12,000 gpm	-
Operating Head Range	10 ft – 34 ft	-
Static Head Range at Minimum Speed	26.5 ft (rated) to 32.5 ft	-
Maximum Pump Speed	900 rpm	-
Power (Full Speed Operation)	218 hp	23.8 hp
Maximum Motor Nameplate Power	235 hp	30 hp
Efficiency (Full Speed Operation)	84%	50%
Impeller Type	Multivane	Vortex

[1]The flow conditions presented are for two duty pumps in operation for a combined flow capacity.
[2] The operating head range defines the range of head over AOR.

2.04 PUMP CONSTRUCTION

A. Impeller Casing:

1. The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. The discharge nozzle shall be flanged and sufficiently rigid to support the pumping unit under all operating conditions.

B. Impeller:

1. The impeller for the Stormwater Duty pumps shall be an enclosed one-piece casting with not more than three non-clog passages. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced.

2. The impeller for the influent channel dewatering pumps shall be an open one-piece casting, vortex style impeller. The passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced.

C. Wearing Rings:

1. The Stormwater Duty Pumps casings and impellers shall have replaceable wearing rings.

2. Casing wearing ring shall be securely fastened to the impeller casing front cover to provide either an axial or radial running clearance. Axially adjustable wearing plate shall be arranged to permit adjustment of the axial running clearance between the impeller and plate. The wearing plate shall have an outward spiraling groove designed to force stringy solids outward and away from the impeller.

D. Oil Chamber Housing (Low Flow Pumps Only):

1. Install the upper seal in an oil-filled chamber with drain and inspection plug (with positive anti-leak seal) for easy access from external to the pump.

2. Motors containing di-electric oils used for motor cooling and/or bearing lubrication are not acceptable.

E. Cooling System (Stormwater Duty Pumps Only):

1. The motor shall incorporate a closed-loop cooling circuit with an integrated cooling pump rated for continuous duty in a completely dry mode; as well as; in a fully submerged condition without damage. The coolant pump impeller shall be mounted directly on the motor shaft between the tandem mechanical seals to circulate coolant fluid into the top inter-space between the cooling jacket and motor housing, over

the surface of the motor, through ducts in the bearing housing and into a volute-casing heat exchanger. Heat losses from the motor shall be transferred to the fluid pumped in the volute-casing heat exchanger, which forms a structural unit together with the discharge cover of the actual waste water pump. After passing through the volute-casing heat exchanger, the medium returns to the suction side of the internal coolant pump. Coolant shall be an environmentally safe antifreeze down to temperatures of minus 20 degrees C (minus 4 degrees F).

2. Motors containing di-electric oils used for motor cooling and/or bearing lubrication are not acceptable. Submergence (cooling) jackets which circulate pumped media for motor cooling are not allowed.

F. Mechanical Seals:

1. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.

2. Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable.

G. Guiderail Mounted Base:

1. A discharge base and discharge elbow shall be furnished by the pump manufacturer. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wet well. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. A profile gasket may be used to ensure a leak free connection between the claw and base

elbow. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.

2. The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the wet well and replaced without the need for operating personnel to enter the wet well.

H. Sliding Bracket:

1. Each guiderail mounted pumping unit shall be provided with an integral, self-aligning guiderail sliding bracket. The bracket shall be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions. The sliding bracket shall be non-sparking where the pump is installed in a hazardous area.

I. Guiderails:

1. Each guide rail mounted pumping unit shall be equipped with one or more guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the location indicated on the Drawings. An upper guiderail bracket shall be provided at the pump access opening.

J. Lifting Cable:

1. Each guide rail mounted pumping unit shall be provided with a cable suitable for removing and installing. The cable shall be 316 stainless steel of sufficient length to retrieve the pump and have a safety factor rated for twice the weight of the pump assembly.

2.05 MATERIALS

A. Materials of Construction:

1. Stator Housing, Oil Chamber Housing, Pump Casing: Cast iron, ASTM A48.

1. Impeller:

a. Duty Pumps: Cast iron, ASTM A48

b. Low Flow Pumps: Chilled Cast Iron (A 532 II B 15% Cr-Mo, 500 BHN Minimum) or equivalent.

2. Casing Wear Rings:

a. Duty Pumps: Semi Austentic CrNi Stainless Steel V 434 (A 890 Grade 5A) or equivalent.

b. Low Flow Pumps: Not applicable for vortex.

3. Bottom Wearing Plate/Discharge Cover:

a. Duty Pumps: N/A

b. Low Flow Pumps: Chilled Cast Iron (A 532 II B 15% Cr-Mo, 500 BHN Minimum) or equivalent.

4. Impeller Wearing Ring:

a. Duty Pumps: Semi austentic CrNi Stainless Steel V 434 (A 890 Grade 5A) or equivalent.

b. Influent Channel Dewatering Pumps: N/A

6. Shaft: Alloy steel, hard chrome plated; or martensitic stainless steel, AISI Type 416 or 420.

7. Mechanical Seals: 2 tandem single type, oil lubricated with silicon or tungsten carbide seal rings at all points, except the upper rotating seal, which shall incorporate one carbon face.

8. Pump Base: Cast iron or fabricated steel.

9. Guiderails: Stainless steel pipe, ASTM A312, Schedule 40S.

10. Upper guiderail bracket, cable hooks, and chain hooks: AISI Type 304 stainless steel.

2.06 ELECTRIC MOTORS

A. General Requirements:

1. Each pump shall be driven by a submersible electric motor provided by the pump manufacturer. Motor nameplate rating shall exceed the maximum power required by the pump in the operating head range. Each motor shall be rated for the power supply provided to the pump, and shall have a service factor of 1.15. The stator housing shall be an air-filled, watertight casing. Where noted, a cooling jacket shall encase the motor housing for each pump where needed to maintain adequate cooling. The cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class H or Class L. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature, and designed for at least 10 starts per hour.

B. Motor Bearings:

1. The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated ABMA L_{10} Life Rating of 100,000 hours when operating at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.

C. Cable Assemblies:

1. All cables for wet well mounted pumps shall be of sufficient length to terminate in a junction box outside the wet well as indicated on the Drawings, with 10 feet of slack which will be coiled on a cable hook at the top of the wet well. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel woven grips (provided by the pump supplier) to prevent damage to the cable insulation. Mounting of cable supports in the wet well shall be coordinated by Contractor to prevent damage to the cable.

2. Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements.

D. Motor Seals:

1. The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

E. Motor Protection:

1. Each motor shall be protected by temperature switches mounted in each phase winding and designed to operate at 150°C ±5°C. The oil-filled seal chamber shall be provided with a moisture detection system furnished by the pump manufacturer, complete with all sensors, cables, control power transformers, auxiliary relays, and junction boxes. Motor protection controls shall be mounted inside the control cabinet. The temperature switches and moisture detection system shall be provided with a

manual reset for explosion-proof pumps and automatic reset for non-explosion-proof pumps.

2.07 VARIABLE FREQUENCY DRIVES

A. General Requirements:

1. Variable frequency drives shall be provided for the Duty Pumps. These drives shall be coordinated with the requirements of the pumping unit.

2. Where applicable motors shall be specifically selected for service with a variable frequency drive and shall be derated to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the variable frequency drive. All motors driven by variable frequency drives shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

2.08 CONTROLS

A. General:

1. Refer to Division 26 for electrical devices and all other controls not specified within this section.

B. Moisture and Motor Temperature Detection System:

1. Each pump/motor housing shall be provided with a moisture and motor temperature detection system complete with all sensors, temperature switches, control power transformers, intrinsically safe control modules, and relays.

2. Power supply to the moisture and motor temperature detection system shall be 120 volt ac. If the required power

supply is less than 120 volt ac the specified control power transformers shall step the voltage down to the required voltage. The motor shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be design to operate at a temperature not to exceed 150 Degree C. Each switch shall be automatic reset type and switches shall be wired in series.

3. The oil-filled seal chamber shall be provided with a moisture sensor furnished by the pump manufacturer. Alternatively, a moisture sensor located in the motor cavity may be used for monitoring. Dry pit submersible pumps shall also incorporate a leakage chamber with float sensor to identify seal leakage and a lower bearing temperature sensor. Each moisture and motor temperature sensor shall be provided with both an open dry output contact and a normally closed output contact each rated 5 amps at 120 volts ac. The contacts shall change state when moisture is detected and or on high temperature. All moisture and temperature monitoring relays shall be furnished by the pump supplier.

4. Pump operation shall be interrupted with motor moisture or motor high temperature conditions. Seal leakage chamber and lower bearing temp shall alarm but not inhibit pump operation.

C. Liquid Level Sensors:

1. Level sensors shall be installed at each location as indicated on the Drawings. Primary and backup liquid level sensors shall be provided for the wet well and influent channel to operate the pumps and other equipment as specified.

D. Control Sequence:

1. Pump Sequence: See Section 40 60 01 Pump Station Control System.

2. Sump liquid level setpoints shall be as indicated in the Drawings. In the event that moisture is detected in the seal chamber or if high motor temperature is detected, the respective alarm light located on the face of the control panel

shall be illuminated and the pump shall be de-energized. The pump shall require a manual restart.

2.09 ACCESSORIES (Not Used)
2.10 MIXES (Not Used)
2.11 FABRICATION (Not Used)

2.12 SHOP FINISHES

1. All exterior metal surfaces of the pump shall be subject to following preparation and coating procedure except name plates, bright parts and stainless steel parts.
2. The preparatory treatment of cast and welded components shall be accomplished in accordance to SSPC near white SP 10.
3. The primer when using Zinc dust or Zinc phosphate base shall have a dry film thickness of not less than 1 1/2 mils (35 microns).
4. An abrasion and shock-resistant, non-porous 2 component epoxy resin base coating shall be used. It shall be resistant against many diluted acids and brines as well as grease, oil, solvents and seawater and especially suited for use in hydrous media. The solids content shall be not less
5. than 82%.The shop-applied top coat shall have a dry film thickness of not less than 6 mils (150microns). The color shall be manufacturer's standard.
6. Name plates shall be masked or removed prior to surface preparation and coating. Polished parts and surfaces (shafts, couplings) shall not be painted but preserved against corrosion. The coating of stainless steel parts is not required but acceptable.

2.13 SOURCE QUALITY CONTROL

A. Non-witnessed Factory Testing:

1. Test each pump under all flow conditions per the design constraints as specified within this section and minimum available submergence (per drawings). Provide minimum of seven test points at full speed and at reduced speed including:

   a. Minimum of six points spanning the AOR

b. One test point at shut-off head

2. Acceptance shall be based on compliance at Full Speed Design Point. Hydraulic Institute tolerance shall be Level 1U for the Duty Pumps and shall be level 2B for the Low Flow Pumps.

3. Provide a submittal as documentation certifying operation of the pumps. Submittal shall be certified by a factory engineer as well as by a Professional Engineer licensed in the State of Ohio.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions:

1. Inspect all items immediately upon delivery to site for damage.

3.03 PREPARATION (Not Used)
3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. Cooling Jacket Fluid: Manufacturer/Supplier shall provide additional coolant for the Duty Pumps equal in volume to the recommended volume of coolant in one pump.

3.06 APPLICATION (Not Used)
3.07 CONSTRUCTION (Not Used)
3.08 REPAIR/RESTORATION (Not Used)
3.09 RE-INSTALLATION (Not Used)

3.10 FIELD QUALITY CONTROL

A. Startup:

1. Field test and calibrate equipment to demonstrate that all equipment operates satisfactorily.

2. Provide test equipment required.

3. Follow testing procedure recommended by manufacturer and approved by the Owner's Representative. Startup testing includes, but is not limited to, the following:

   a. In the presence of the Manufacturer, the Contractor shall utilize the disconnect off at each pump to force level reading manually and to confirm the protective alarms stop pump operation in all operating modes.

   b. The pump station operator shall keep a record of the first three rain events that trigger the duty pumps. The record shall at a minimum include information on the water level and associated VFD speeds, amps, and volts while running. Data may be collected using the SCADA system online or in person at the station. The data shall be used to confirm the control system tuning is operating in accordance with the Drawings and shall be confirmed by the Manufacturer and the Design Engineer.

   c. An Owner's Representative shall be present during the first rain event that triggers the duty pumps to confirm there are no visual issues with the internal piping, valves, pumps, or any other components within the wet well and valve vault that are integral to a satisfactorily operating pump station.

4. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences.

5. In the event that the manufacturer is unable to demonstrate to Owner's Representative that the equipment meets the requirements of the tests, the deficient equipment will be rejected and CONTRACTOR shall adjust and modify and retest the equipment as often as necessary to meet the

specified requirements. No separate payments shall be made for adjustments and/or modifications.

B. Manufacturer's Field Service: Retain a qualified factory trained representative of the manufacturer for a minimum of four trips each including 8 hours on site, or more as necessary, to perform the following services:

1. Check installation of all equipment and accessories specified herein including verification of coolant and oil levels.

2. Inspect each installation and note deficiencies.

4. Assist CONTRACTOR during operation, adjusting, and field testing of each installation.

5. Contractor shall be responsible for provision of lifting equipment during startup to allow removal and re-installation of pumps to allow for rotation checks and verification of guide rail alignment.

6. Prepare installation report and submit immediately after completion of field testing; report to include

a. Description of installation deficiencies not resolved and recommended corrective action.

b. Statement certifying that pumps and appurtenances are properly installed in accordance with manufacturer's requirements and recommendation except for deficiencies noted above.

3.11	ADJUSTING	(Not Used)
3.12	CLEANING	(Not Used)
3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +

SECTION 46 21 10

MANUALLY CLEANED TRASH RACK

PART 1 GENERAL

1.01 SUMMARY

A. The work covered under this section includes the furnishing of all labor, materials, accessories, tools, equipment, transportation services, and performance of all operations required to install a new manually cleaned trash rack.

B. Furnish all labor, materials, equipment and incidentals required to provide trash rack, perforated steel drainage plate, and appurtenant structural framework and anchoring equipment.

C. Related Sections:

1. Section 05 05 01, Anchor Bolts, Expansion Anchors, and Concrete Inserts

2. Section 09 91 10, Painting

1.02 REFERENCES

A. Reference Standards:

1. ASTM A276, Standard Specification for Stainless Steel Bars and Shapes

2. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

3. ASTM A354, Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

4. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

1.03 DEFINITIONS (Not Used)

1.04 SYSTEM DESCRIPTION

A The trash rack is sized to provide protection for the stormwater pumps. The perforated plate provides drainage of raked material collected on the bar screen and shall be capable of supporting a 300 psf load.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit complete Shop Drawings including dimensions, materials and parts lists.

2. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.

1.06 QUALITY ASSURANCE

A. At the Engineer's request, the equipment manufacturer shall certify to not less than five (5) years of experience in the application, design, and manufacture of manually cleaned trash racks of the type specified herein.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:

1. Store materials in a secure location to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect

steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:

1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify Owner's Representative, in writing, if any loss or damage exists to equipment or components or if there is a deviation from the approved Shop Drawings. Replace loss or deviations and repair damage to new condition in accordance with manufacturer's instructions.

1.08 PROJECT/SITE CONDITIONS (Not Used)
1.09 SEQUENCING (Not Used)
1.10 SCHEDULING (Not Used)

1.11 WARRANTY

A. The Contractor shall provide warranty for the equipment to be free of material or workmanship defects for one (1) year from the date of final completion. During that year, the Contractor shall, at no expense to the Owner, replace any part or parts that fail due to defective manufacture or installation.

1.12 SYSTEM STARTUP (Not Used)
1.13 INSTRUCTION OF OWNER'S PERSONNEL (Not Used)
1.14 COMMISSIONING (Not Used)
1.15 MAINTENANCE (Not Used)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. E & I Corporation – Basis of design

B. Approved Equal

2.02 DESIGN CRITERIA

A. The heavy duty trash rack shall be suitable for installation in a flow channel per the dimensions as indicated on the Contract Drawings. The angle of inclination shall be 60 degrees from horizontal.

B. Each screen shall be capable of passing a maximum of 120 cfs of untreated stormwater with an upstream water depth of 15 feet based on a nominal unit width of 18'-8" wide as shown on the Contract Drawings.

C. The bar rack shall be designed to withstand load when the bars are 100 percent clogged by debris.

2.03 MATERIALS (Not Used)
2.04 MANUFACTURED UNITS (Not Used)

2.05 EQUIPMENT

A. Trash rack bars shall be constructed of galvanized hot-dipped steel or Grade 304 stainless steel. The bar rack shall consist of flat galvanized hot-dipped steel bars. The dimensions of the bars are 1/2 inch by 3 inches (0.5 inch by 3 inches). The screen field shall be accurately constructed to provide a clear opening of inches between the bars. There shall be no space wider than the opening between the bars that would permit passage of larger solids through the screen.

B. Stationary, removable panel, bar rack assemblies and all anchoring supports shall be fabricated and erected as detailed on the Contract Drawings.

C. All anchor bolts and hardware shall be 316 stainless steel.

2.06 COMPONENTS (Not Used)
2.07 ACCESSORIES (Not Used)
2.08 MIXES (Not Used)
2.09 FABRICATION (Not Used)

2.10 FINISHES (Not Used)
2.11 SOURCE QUALITY CONTROL (Not Used)

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS (Not Used)

3.02 EXAMINATION

A. Site Verification of Conditions:

1. Inspect all items immediately upon delivery to site for damage.

3.03 PREPARATION (Not Used)
3.04 ERECTION (Not Used)

3.05 INSTALLATION

A. Installation shall be in strict accordance with the Contract Documents and the requirements outlined in the manufacturer's written instructions and shop drawings. It is the Contractor's responsibility to verify the accuracy of all necessary dimensions in the field to ensure compatibility with the specifications and equipment.

B. The bar rack manufacturer shall inspect the installation of the manually cleaned trash rack to assure that the unit has been installed in accordance with the manufacturer's written recommendations.

C. In the event that equipment is supplied which is different than specified, it shall be the responsibility of the Contractor to coordinate and make all changes to related structures, drawings and documentation. All changes must be reviewed and approved by the Engineer prior to any installation work commencing. In addition, all costs associated with such changes, including additional time required for review of the changes by the Engineer, shall be borne by the Contractor.

3.06	APPLICATION	(Not Used)
3.07	CONSTRUCTION	(Not Used)
3.08	REPAIR/RESTORATION	(Not Used)
3.09	RE-INSTALLATION	(Not Used)

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Retain a qualified factory trained representative of the manufacturer for a minimum of 8 hours, or more as necessary, to perform the following services:

1. Check installation of all equipment and accessories specified herein.

2. Inspect each installation and note deficiencies.

3.11	ADJUSTING	(Not Used)
3.12	CLEANING	(Not Used)
3.13	DEMONSTRATION	(Not Used)
3.14	PROTECTION	(Not Used)
3.15	SCHEDULES	(Not Used)

+ + END OF SECTION + +